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CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Notes of Ship-Building in New York and Vicinity.

JUDGING from present indications, it would seem that the shipping business of New York and its vicinity is to experience a great revival from the dullness and stagnation which has heretofore prevailed. During the past four years, there has been a general depression among ship-builders, whilst ship-owners have been steadily sinking immense sums of money, much less realizing those handsome incomes, which, a few years since, marked the business of navigation; they have not only experienced very light freights, but have been compelled to see their once magnificent and busy vessels lying idle, and rotting at their docks for lack of employment.

But now, the aspect has changed, and it is sincerely hoped that the gratifying signs at present universally manifest, will not be spasmodic and soon pass away, but that prosperity of trade in general, and a succession of good crops, will follow and create a constant demand not only for the fine vessels afloat, but for new and improved ones, which New York and vicinity have almost unlimited means of supplying.

The cause of the present activity in our ship-building is easily explained. It is the great abundance of crops throughout the whole extent of our Union, for which the comparative dearth in Europe necessarily creates an extensive demand; this is, undoubtedly, the prin-

cipal cause, but there are others, equally important, to which it is attributable, viz: the unexampled success attending the many efforts of our respective ship-builders.

Science and art have extended their aid in no other department of handiwork more particularly than in this. American skill and American ingenuity have produced models in this respect which are everywhere recognised as the best; and it is but recently that special agents were sent to this country by foreign powers to superintend the erection of vessels intended for them; but of this a single word hereafter.

The prominent feature of the work as at present in progress throughout the various ship-yards, is the large number of steamers upon the stocks. But few packet ships are in course of construction: in fact, the smallest vessels are being built with steam power to propel them. This little circumstance only proves how rapidly the revolution from canvass to steam is progressing, and indicates that ere long sailing vessels will be entirely superseded by steamers, particularly for the coasting trade.

Visiting a ship-yard to me is always pleasant, but at the present period far more so than usual; as the busy hum, the merry chorus of the ringing axes and clanking hammers, present indubitable evidence of the great activity with which the work is progressing. Annexed will be found a review of the operations now in progress at our yards, which will give an impression of the state of the business.

The Steamer Guadalquiver.

Hull built by Jacob Westervelt & Co., New York. Machinery to be constructed by a foundry in Cuba. Owners, parties in Havana. Intended service, coasting around the island of Cuba.

HULL.—Length on deck, 160 feet 6 ins. Breadth of beam (molded), 23 feet 8 ins. Depth of hold, 10 ft. Depth of hold to spar deck, 10 ft. 3 ins. Frames—molded, 11 ins.—sided, 5½ ins.—apart from centres, 20 ins., and square fastened with copper, &c. Draft of water, 4 feet; when fully equipped for service, with her engines and coal, will draw 6 ft. of water Masts, two—Rig, schooner. Tonnage, 375 tons.

MACHINERY.—To be put in immediately after her arrival in Cuba. Of its dimensions or description, I have no knowledge.

Remarks.—This vessel is of a beautiful model, with very sharp and easy lines. Her frame is of live oak; the keelsons and ceiling of yellow pine; the planking is of yellow pine and white oak. The decks are of yellow pine, and the combings of mahogany.

The Steamer John P. King.

Hull built by Jacob Westervelt & Co., New York. Machinery in process of construction by the Allaire Works, New York. Owners, Spofford, Tileston & Co. Intended service, New York to Charleston, S. C.

HULL.—Length on deck, 236 ft. Breadth of beam (molded), 36 ft. 6 ins. Depth of hold, 13 ft. 8 ins. Depth of hold to spar deck, 21 feet. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins., and very securely fastened with copper, &c. Tonnage, 1572 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return flue. Length, 26 feet. Breadth, 12 ft. 3 ins. Height, 12 ft. 3 ins.

PADDLE WHEELS.—Diameter over boards, 28 ft. Material of iron. Number, 24.

Remarks.—This steamer is very strongly built, her frame being white oak throughout. Her model is handsome and such as to insure great speed. This vessel was named in honor of the President of the Georgia Railroad. Capt. Richard Adams, formerly of the *James Adger*, will command her.

The Steamer John P. Jackson.

Hull built by Devine Burtis, Red Hook, L. I. Machinery in process of construction by Wm. Birkbeck, Jersey City. Owners, New Jersey Ferry Company. Intended service, New York to Jersey City.

HULL.—Length on deck, 210 ft. Breadth of beam (molded), 33 ft. 6 ins. Depth of hold, 12 ft. 8 ins. Draft of water, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 6 ins.—apart from centres, 16 ins. Her frame is of white oak, chestnut, &c., and very securely fastened with copper and treenails. Tonnage, 860 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 11 feet.

BOILER.—One—Drop flue. Length, 30 ft. Breadth, 10 feet. Height, 10 feet. Has water bottom. Location in hold. No blowers.

PADDLE WHEELS.—Diameter over boards, 21 ft. Material of wood. Number, 18.

Remarks.—This ferry boat is probably the largest of its kind in the world: it certainly will be one of the most capacious and splendid vessels of its class on our rivers, when finished. Her wood work consists of the best quality of oak, locust, and mahogany. She has one independent steam, fire, and bilge pump, and ordinary bilge injections. Contrary to general usage with such boats, her bottom was entirely coppered at the period of launching. It is customary not to copper them until they have been in service about six months. Her aggregate cost will be $60,000. She will take her appropriate position on the Jersey City Line about the first of November.

The Steamer Fire Dart.

Hull built by Thomas Collyer, New York. Machinery in process of construction by the Neptune Iron Works, New York. Owners, Augustine Heard, Jr., & Co., Boston. Commander, Henry W. Johnson. Intended service, coast of China.

HULL.—Length on deck, 200 ft. Breadth of beam (molded), 30 ft. Depth of hold, 11 ft. Do. to spar deck, 11 ft. 3 ins. Draft of water at load line, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 5 ins.—apart from centres, 26 ins. Her frame is of white oak, &c., and fastened in the most thorough manner. Tonnage, 650 tons. Masts, two—Rig, Schooner.

ENGINES.—Vertical beam. Diameter of cylinder, 46 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return flued. Length, 27 feet. Breadth, 9 feet 10 inches. Height, 8 ft. 9 ins.

PADDLE WHEELS.—Diameter over boards, 28 ft. Length of blades, 8 ft. Depth, 2 ft. Number, 24.

Remarks.—This steamer has been constructed of the best materials and put together in a masterly manner. Her model appears to be without fault. She is furnished with guards similar to a steam-ship, and will be enclosed to the promenade deck. Her value when finished will be about $85,000. Mr. Collyer is erecting other vessels (of which mention will be made below) for parties in Boston and China. This builder seems to have achieved a celebrity in the East somewhat akin to other builders with us. It has not been long since papers published in England contained an account of the performances of a new steamer sent from the Clyde, in contrast with the steamer *Yang-tse*, built by Mr. Collyer, and which had been running in Chinese waters a period of three years; they made the reluctant admission that though the former cost nearly three times as much on the Clyde as the latter did in the United States, she consumed double the amount of coal, and had less capacity for freight and passengers, thereby showing a clear triumph for the American steamer.

The Steamer Primeira.

Hull built by Webb & Bell, Green Point, L. I. Machinery in process of construction by the Novelty Iron Works, New York. Owners, Dr. Raney and others, Rio Janeiro, S. A. Intended service, Bay of Rio Janeiro.

HULL.—Length on deck, 130 ft. Width over guards, 50 ft. Breadth of beam, 28 ft. Depth of hold, 10 feet. Do. to spar deck, 9 ft. 6 ins. Draft of water at load line, 6 ft. Floors—molded, 13 ins.—sided, 9 ins.—apart from centres, 24 ins. Frames very securely fastened. Tonnage, 350 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 32 ins. Length of stroke of piston, 8 ft. To be of 180 horse-power, calculated to insure a speed of 12 knots per hour.

BOILER.—Drop flue. Length, 21 ft. Breadth, 8 ft. 6 ins. Height, 8 ft. 6 ins.

PADDLE WHEELS.—Diameter over boards, 16 ft. Length of wheel blades, 6 ft. 8 ins. Depth, 2 ft. Number, 14.

Remarks.—This vessel is most appropriately called the *Primeira* (first), and is one of three which are intended for the use of our southern imperial neighbor, designed for service as above stated. Dr. Raney, a gentleman of great energy and enterprise, after a year of most incessant labor, and encountering the combined opposition of the old Thames boat ferry company and the whole English influence, which has monopolized the steam-ship business in Brazil ever since the introduction of steam power, last winter succeeded in establishing a company for running steamers on the American plan, and obtaining a charter from the government, conferring the right of navigating the Bay of Rio Janeiro for a period of thirty years. As no other steamer has ever been built for that country by American ship-builders, it is

reasonable to hope that this will give such a good account of herself as to secure more business of the same kind for our yards.

This vessel is constructed with extraordinary strength, her materials being principally of white oak. The ceiling and planking are of 2½ inch white oak, with double frames of the same, continuing from stem to stern, and strongly copper fastened. The manner of her whole construction is highly creditable to the skill of Messrs. Webb & Bell, and gives great satisfaction to her owners. The keel of the other two will be laid immediately. Their aggregate cost will be $180,000.

The Clipper Bark, D. Golden Murray.

Hull built by E. Lupton, Green Point, L. I. Owner, D. Golden Murray, City of New York. Commander, Capt. Richard Lee, formerly of the bark *Lucky Star*. Superintendent of construction, J. C. Conner. Intended service, New York to Galveston, Texas.

HULL.—Length of keel, 112 feet. Do. of main deck, 122 feet. Do. over all, 133 ft. Breadth of beam at midship section, 30 feet. Depth of hold, 12 feet 6 ins. Frames of white oak, &c., &c., and thoroughly fastened. Tonnage, 510 tons.

Remarks.—The model of this bark bespeaks speed and excellent carrying abilities. She is capable of bearing 835 tons dead weight, and then will draw but ten feet of water. She has been fitted with all the modern improvements, having double topsail yards and patent reefs in her courses. There are seven vessels now belonging to this line of packets, and it is expected that this, the last addition, will fully sustain their excellent reputation.

THE ABOVE SIX VESSELS HAVE BEEN LAUNCHED WITHIN A VERY BRIEF PERIOD, AND ARE NOW UNDERGOING THE PROCESS OF COMPLETION WITH ALL POSSIBLE DESPATCH.

The following are still on the stocks, or about being commenced:—

At Thomas Collyer's, New York.

A day boat to run between New York and Albany has just been commenced. She is to run with great economy of fuel, and to be of good speed. The subjoined are some of her dimensions:—

HULL.—Length on deck, 250 ft. Breadth of beam (molded), 30 ft. Depth of hold to spar deck, 10 ft. Frames—molded, 15 ins.—sided, 4 ins.—apart from centres, 30 ins. Draft of water, 5 ft. Tonnage, 700 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke of piston, 10 feet.

BOILERS.—Two—Return flued. Length, 29 ft. Breadth, 9 ft. Height, 9 ft. 5 ins. Number of furnaces, two in each.

PADDLE WHEELS.—Diameter over boards, 30 feet. Length of blades, 9 feet. Number of do., 24.

The machinery to be constructed, I understand, by the Neptune Iron Works.

Also, a steamer for Messrs. John W. Forbes & Co., of Boston, Mass., under the superintendence of George N. Sands, is building here. To be named the *Hankow*.*

* Since launched.

HULL.—Length on deck, 212 feet. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold, 11 ft. 6 ins. Draft of water at load line, 7 ft. Floors, molded, 14 ins.; sided, 7 ins.; apart from centres, 27¼ ins. Tonnage, 750 tons. Two masts, schooner rigged. Machinery to be constructed by the Morgan Iron Works.

ENGINES.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return tubular. Length, 20 feet. Breadth, 11 feet. Height, 9 ft. Two furnaces in each boiler.

PADDLE WHEELS.—Diameter over boards, 29 ft. Length of wheel blades, 7 ft. 6 ins. Depth, 2 ft. Number, 26.

This vessel will be made very strong, being iron strapped throughout and well timbered. Materials used, white oak, chestnut, &c. It will cost, when finished, $90,000.

This is the third vessel erected for the China trade for Messrs. Forbes & Co., and three others have been constructed for the Chinese waters; one of which was sold to the French government for a war steamer, and another purchased by the Chinese government for war service, to protect their junks from the depredations of the river pirates who infest their waters. The others are actively employed on the rivers.

Another steamer of smaller dimensions than the above is also in process of construction, for parties in New York, who design placing her in the coasting and river trade in the Chinese Empire.

Her length will be 160 feet. Breadth of beam (molded), 26 ft. Depth of hold, 10 feet. Not yet named. Machinery by the Morgan Iron Works.

In many respects, the details of her construction will be similar to the *Hankow*.

At Henry Steers', Williamsburgh, L. I.

A beautiful side-wheel steamer is being constructed at this place, under the superintendence of Edward N. Dickerson. She is intended to run in conjunction with the Florida Railroad, along the Gulf Coast, between Cedar Keys and New Orleans.

Her dimensions will be as follows:—

Length on deck, 285 feet. Breadth of beam (molded), 37 ft. 6 ins. Depth of hold, 13 feet. Tonnage, 1350 tons.

Another steamer of similar construction will soon be commenced by Mr. Steers.

At Sneden & Rowland's, Green Point, L. I.

A large side-wheel steamer, to run between New York and New Haven, is in process of erection here. Her dimensions will be as follows:—

HULL.—Length on deck, 280 ft. Breadth of beam (molded), 35 ft. Depth of hold, 11 ft. Draft of water, 6 ft. Frames, of white oak, chestnut, and cedar, copper fastened, and diagonally and double laid with iron straps, 3½ by 9-16ths of an inch. Tonnage, 1200 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 65 inches. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return flued.

PADDLE WHEELS.—Diameter over boards, 28 feet.

The machinery is to be constructed by the Neptune Iron Works, New York.

The erection of two more steam vessels has also been commenced. They are intended for the Norwich and New York Steam Navigation Co., to run in conjunction with the Norwich and Worcester Railroad. Their principal dimensions will be:—

Length on deck, 300 feet. Breadth of beam (molded), 37 ft. 6 ins. Depth of hold, 13 feet. The contract for constructing the machinery has just been completed with the Novelty Iron Works. They will have beam engines, with a cylinder 75 inches in diameter, and stroke of piston of 12 feet. Their tonnage will be 1350 tons each.

The keel of an iron propeller has also been laid. She is building for Pezant Bros. & Co., to run between Mexico and Cuba in the cattle trade. Her dimensions will be:—

Length on deck, 135 feet. Breadth of beam, 22 feet. Depth of hold, 5 feet. She will be supplied with Ericsson's hot-air engine. Tonnage, 300 tons.

This firm will immediately begin an iron steamer for the New Orleans and Mobile mail route. The machinery, I understand, is to be constructed by the Morgan Iron Works. I append her principal dimensions:—

HULL.—Length on deck, 250 feet. Breadth of beam, 34 feet. Depth of hold, 10 feet. Floors—┐, molded, 3½ ins.—sided, ⅞ths of an inch. Frames—angle iron, 3½×3½×⅞—apart from centres, 18 ins. Five single plates, fore and aft. Keelsons, having four angle bars on each, I. Keel, U, ⅞ thick. Tonnage, 650 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke of piston, 10 feet.

BOILER.—Return flued.

PADDLE WHEELS.—Diameter over boards, 30 feet, with a face of 10 feet.

At Lawrence & Foulk's, Williamsburgh, L. I.

They have upon the stocks and nearly completed a steamer for the Spanish Government, intended for towing purposes in the harbor of Havana. Her dimensions are:—

Length on deck, 100 ft. Breadth of beam, 24 ft. Depth of hold, 9 ft. 6 ins. Tonnage, 275 tons.

MACHINERY—By the Fulton Iron Works.

ENGINE.—Vertical beam. Diameter of cylinder 30 ins. Length of stroke of piston, 6 feet.

The cost of this boat, when finished, will be $30,000.

At Wm. H. Webb's, New York,

Is now building a magnificent side-wheel steamer for Saml. L. Mitchell's New York and Savannah Line. Her dimensions will be:—

Length on deck, 250 ft. Breadth of beam (molded), 38 ft. Depth of hold, 22 ft. 6 ins. Tonnage, 1750 tons.

These dimensions will make her considerably larger than any vessel on the line, and will increase the number of running ones to four side-wheel steamers and one propeller. Machinery by the Morgan Iron Works.

Mr. Webb is also building a large packet ship for the Black Ball Line. Owners, Charles H. Marshall & Co., City of New York. She will be constructed of white and live oak and locust, and possess two decks. Her dimensions are:—

Length on deck, 278 ft. Breadth of beam, 39 ft. Depth of hold, 23 ft. Tonnage, 2000 tons. Will be completed about the middle of November.

A brig of 270 tons is also building here. Her destination will be the Brazos River.

At S. Allison's, Jersey City.

A steamboat for Roman & Tremper, Kingston, N. Y., is building here. The route of her intended service will be between the City of New York and Kingston, on the North River. Her dimensions are:—

Length on deck, 242 feet. Breadth of beam (molded), 34 ft. 3 ins. Depth of hold, 9 feet. Engine of 56-inch cylinder, and 12 feet stroke of piston.

She will be finished in the course of two months, and will then take the place of the *North America*, which is getting very old.

At Webb & Bell's, Green Point, L. I.,

Is building a fine steamer for the Stonington Line. She will be 272 feet in length, 32 feet beam, and 10 feet depth of hold. The Novelty Iron Works will construct the machinery.

They have also on the stocks a brig of 250 tons, for I. & N. Smith & Co., City of New York, to run between New York and the West Indies. Her dimensions are:—

Length on deck, 117 ft. Breadth of beam, 27 ft. Depth of hold, 8 ft. 6 ins.

Her cost will be $120,000.

At Roosevelt, Joyce & Co.'s, New York.

They have in course of erection at their yard four ferry boats, each of 500 tons burthen. Two are for the Union Ferry Co., and the others for the East River Ferry Co., City of New York. The latter intending to ply between Hunter's Point and New York, in connexion with the Long Island Railroad Company. The former will run between the City of New York and Brooklyn. The machinery of the lot will be supplied by the Allaire Iron Works. The cylinders of the engines will be 34 inches in diameter, with a stroke of piston of 9 ft.

At Novelty Iron Works, New York.

At this place a beautiful iron screw steamer is now building. Owners, H. Cromwell & Co. Intended service, New York to Wilmington, N. C. Her principal dimensions will be:—

Length on deck, 180 ft. Breadth of beam, 25 ft. Depth of hold, 15 ft. Her hull will be of iron, whilst the upper portion will consist of wood, constituting her one of the

staunchest vessels in our waters. Her engine will be of 42 inches diameter of cylinder, with a stroke of piston of 3 ft. 6 ins. Her propeller will be 12 feet in diameter. Tonnage, 650 tons.

These works have also contracted to erect an iron steamer, 100 feet in length, for parties in Carthagena, South America.

Thus, it will be seen by these particulars that no surer or more reliable index of the skill of our mechanics and the prosperity and welfare of our commercial relations can be found, than in the activity of the ship-building trade of the City of New York and its vicinity.

E. B.

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*The Incrustation of Boilers.**

Mr. James R. Napier, ship-builder and engineer, of Glasgow, submitted to the Philosophical Society of that city, on the 18th ult., a very interesting paper on the incrustation of boilers using sea-water, to which we think it desirable to draw particular attention. It appears that on a former occasion Mr. James Napier, chemist, read a paper on the same subject to the Society, in which he made certain suggestions. Feeling much interested in these suggestions, Mr. James R. Napier put them to trial on board the Islesman, on a voyage to the north of Scotland in 1858, in order, if possible, to see the effect. On this occasion, we are told, half a pound of dissolved soda ash was forced into the boiler along with the feed-water at 9h. 30m.; at 11h. 30m. another half pound was forced in; at 3h. 30m. one pound was forced in; and at other times, more was put in. The only effect observed by these operations was making the water in the gauge glass of a milky appearance within a few minutes after the soda was introduced; it continued so for probably an hour after each injection, a small pipe near the surface of the water allowing a continuous discharge from the boiler.

The experiments showed that if the system proved economical, a simple plan could easily be arranged for carrying it out. But as Mr. Napier, in his paper, states "that this sort of crust (sulphate of lime) cannot be avoided by care or mechanical means, except by keeping the salt in the water under its crystallizing quantity, which would necessitate such an amount of blowing off and supply as would render it expensive," the expense of both methods was calculated—the chemical one of neutralizing the sulphate of lime with soda, and the mechanical one of an abundant discharge and supply, so as to keep the sulphate of lime under its crystallizing quantity. It is necessary for this purpose to know the relative proportions of feed-water, and water required to be discharged, in order to prevent scale or crust. Many writers treat this crust, says Mr. J. R. Napier, as if it were common salt, and instruct persons how to make and graduate instruments for ascertaining its quantity, the graduations being effected by observing

* From the London Mechanics' Magazine, Feb., 1860.

the depths to which the instrument sinks in water in which certain proportions of common salt has been dissolved. They say, sea-water contains 3 per cent. of salt, and when the boiler contains less than 12 per cent. there will be little or no crust; therefore it is necessary to blow off 3-12ths or 1-4th of the feed-water, in order to prevent the formation of crust. This reasoning, however, as Mr. Napier remarks, is unsatisfactory; as it is evident to any one who has the sense of taste, that the crust is not common salt; and chemical analysis shows that sea-water from the English Channel, although it contains nearly 3 per cent. of common salt, contains only about 0·8 per cent. of the materials forming the crust, and only 0·14 per cent. of the material of which, according to Mr. Napier, chemist, upwards of 90 per cent. of the crust is composed. It is also shown by analysis that a saturated solution of this material (sulphate of lime) in cold distilled water, is as 1 to 380, and as 1 to 388 in boiling water, or 25·7 parts of lime to 10,000 of solution. Mr. Napier, however, found 203 grains of sulphate of lime per gallon in water taken from a boiler off Ailsa Craig. Its density is not stated; but assuming it to contain twice its natural quantity of saline matter, or its density to be 1·0548, sea water being 1·0274,—this gives the ratio 203 to 73,836, or 1 of sulphate of lime to 364 of solution, or 27·47 of sulphate of lime to 10,000 of solution. This proportion, it is inferred, is either a saturated solution, or such as the engineer of the vessel found little or no crust formed in. For want of better data, 28 of sulphate of lime to 10,000 of solution is assumed as the limit of saturation in boilers using sea-water, working at pressures not exceeding 20 lbs. above the atmosphere. This is equivalent to discharging 14-28ths, or one-half of the feed-water. This assumption is confirmed by the practice of the British and North American Mail Company; by Mr. Napier's Ailsa Craig engineer, who was evidently blowing off nearly this amount; and by an experiment of Mr. Thomas Rowan, of Glasgow, made for the purpose of ascertaining when the sulphate of lime and when the common salt deposited. He found, when he

evaporated	2-10ths	of the water, a trace of sulphate of lime deposited.
"	4-10ths,	ditto, ditto.
"	5-10ths,	the sulphate of lime began to deposit in larger quantities.
"	6-10ths,	ditto, decided quantities.
"	8-10ths,	sulphate of lime deposited in very large quantities; also magnesia and salt began to form.

"Mr. Rowan's experiment," says Mr. J. R. Napier, "although indefinite as to the quantities, shows that the sulphate of lime begins to deposit before even one-half of the water is evaporated. It is probable, therefore, that this quantity, or more, would require to be discharged in order to prevent the formation of crust in boilers."

A saturated solution of common salt in distilled water is given as 27 of salt to 100 of solution; and a saturated solution in sea-water is

said to be 36 of salt to 100 of solution. The former ratio has been chosen for comparison in this case, so that 27-270ths, or only 1-10th, of the feed-water would require to be discharged in order to prevent the formation of common salt, and 8-10ths to be neutralized by soda to prevent the deposit of sulphate of lime, the 1-10th discharged being a saturated solution of sulphate of lime and common salt. It is thus shown, that by the chemical method it is necessary to discharge 1-10th of the feed-water, and neutralize the sulphate of lime in 8-10ths of it with soda, according to Mr. Napier's method, to prevent crust; and by the mechanical method, it is necessary to discharge 5-10ths. The quantity of soda ash (supposed to contain 50 per cent. soda) is found by the formula $\frac{6}{68}$ of $\frac{14}{10000}$ of $\frac{8}{10}$ of feed-water.

For the purpose of illustrating the expense of both methods of preventing crust, and also the loss by the blowing-off method, the case of a vessel has been taken by Mr. J. R. Napier, working at a temperature of 270°, and evaporating at that temperature 7½ lbs. of water from 100° per lb. of coal.

		Chemical Method.
Sea-water supplied to boiler, temp. 100°,	15·0 lbs.	8·33 lbs.
Water discharged, 270°,	7·5 "	0·83 "
Water evaporated,	7·5 "	7·5 "
Total heat evaporating from 100° at 270° $h_{1\cdot2}$ $= 1092 + 3\text{-}10\,(T_1 - 32, - (T_2 - 32)$ $= 1095$·	8215°·5	8215°·5
Heat discharged,	1275°	142°
Fuel consumed in evaporation,	1·0 "	1·0 " coal.
Fuel consumed in preventing crust,	0·155 lbs. coal,	0·0172 lbs. coal + 0·0085 lbs. soda ash.
Total fuel,	1·155 lbs. coal,	1·017 lbs. coal + 0·0085 lbs. soda ash.

Thus, it is seen that it requires only 172 lbs. coal + 85 lbs. soda ash, containing 50 per cent. soda, to be as efficient in preventing crust as 1550 lbs. of coal alone, which evaporates 7½ lbs. water from 100° at 270°. And these methods are equally expensive when the soda ash is 16·2 times dearer than the coal. This ratio varies with the efficiency of the fuel and the temperature of evaporation.

Although when coals are 10*s.* and soda ash £10, Mr. Napier's method is more expensive than the ordinary one of discharging the saturated water, there are many cases where it is probable the owners of vessels would profit by its adoption. In long voyages, for example, a vessel requiring by the ordinary mode 1155 tons of coal, would by Mr. Napier's method require, as Mr. J. R. Napier remarks, 1017 tons coal, and 8½ tons soda ash, or 1025½ tons weight. There would be a saving in money, therefore, of 138 tons coal, 129 tons of freight, and 8½ tons of soda ash; or if coals are 10*s.* per ton, freight £3, and soda ash £11 per ton, the saving would be £362. That boilers, however, can be worked till the water in them is nearly saturated with common salt, or that the soda ash can be so accurately proportioned as *exactly* to neutralize the sulphate of lime, are problems which are believed to be new, and have not yet been attempted. The considerable saving which may be effected, shows that the method is worthy of a trial.

We quote the following remarks from the conclusion of Mr. J. R. Napier's paper:—

"From the foregoing example," he says, "of a vessel worked at a temperature of 270°, it is also seen that a quantity of fuel, equal to 15½ per cent. of that which produces evaporation, is consumed by the ordinary blowing-off method, in order to prevent crust, and this amount increases with the temperature. Brine chests have been frequently used for the recovery of this notable loss; but apparently from a misapprehension of the quantity of water necessary to be discharged, and a want of knowledge of the amount of surface required to absorb the discharged heat, of a capacity greatly too small for their purpose. If Peclet's formula for calculating this surface is to be trusted, those chests on board the West India mail steamship *La Plata*, and some of the British and North American Company's packets, are 1-15th to 1-20th of the size that would be efficient. When these brine chests, regenerators, or heat economizers, therefore, are made with a *sufficient* amount of surface, so that abundance of water can be supplied to and discharged from the boilers with little loss of heat, then there will be no incrustation of boilers, and a probable saving of from 12 to 13 per cent. of their fuel. Peclet's formula, or Professor Rankine's reduction of it, which gives the probable amount of surface required for a difference of temperature of 140° between the feed and the discharged water, at 1-10th square foot per lb. of brine discharged per hour, becomes under the same circumstances, and when the quantity of brine discharged is equal to the quantity of water evaporated, 1-10th square foot of surface per lb. of water *evaporated* per hour. The introduction of Dr. Joule's spiral wires to the system will probably render less surface efficient. This amount of discharge and surface, it is expected, will prevent incrustation, and save nine-tenths of the heat at present lost."

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*On the Construction of Artillery and other Vessels to resist great internal pressure.** By J. A. Longridge, M. Inst. C. E.

It was stated in the outset, that it was not proposed to treat of the very wide range of subjects involved in the construction of the most perfect description of ordnance, but to limit the inquiry to the question, how to make a gun of sufficient strength to enable the artillerist to obtain the full effect of the explosive compound used in it? This question was one which the civil engineer was probably more fitted to deal with than the artillery officer, inasmuch as it required nothing beyond a knowledge of the properties and laws of action of those materials with which his every-day practice made him familiar.

The attention of the author was drawn to the subject early in the year 1855. Following up the reasoning of Prof. Barlow on hydraulic press cylinders, he was led to consider how the internal defect of any homogeneous cylinder could be remedied. Prof. Barlow had shown, that in every such cylinder the increase of strength was not in pro-

* From the Lond. Civ. Eng. and Arch. Journal, Mar., 1860.

portion to the increase of thickness, and that a vessel of infinite thickness could not ultimately resist an internal pressure greater than the tensile forces of the material of which it was composed. The material at the internal circumference might, in fact, be strained to its utmost, when that at the outside was scarcely strained at all. To remedy this, it was necessary that each concentric layer of the gun or cylinder should be in an initial state of stress, such that when the pressure was applied, the sum of the initial and the induced stresses should be a constant quantity throughout the whole thickness of the cylinder. It occurred to the author that this could be accomplished by forming the gun or cylinder of a thin internal shell or case, and coiling round it successive series of wires, each coil being laid on with the tension due to its position.

The principle of building up a gun in successive layers, with increasing initial tension, was, therefore, that which it was intended to bring forward in this paper. The author claimed no exclusive merit for this idea. Although then unknown to him, it was being followed up by Capt. Blakely, Mr. Mallet, and others, who, however, sought for its practical outcome in rings or hoops, contracted or forced on to the central core. Capt. Blakely had, equally with the author, the idea of making use of wire, although his experiments were entirely confined to hoops. It was in complete ignorance of what others were doing that the author undertook the experiments recorded and described in detail in the present paper. The results were so striking, that he lost no time in bringing them before the War Department. The usual reference was made to the Select Committee at Woolwich, with the usual result. The principle was pronounced to be defective, and not such as to warrant any trials at the public expense. The author, however, continued his experiments, and the results were such as entirely to confirm his confidence in the practical utility of the invention.

Before describing these experiments, the paper referred to the construction of guns as hitherto practised. It was first shown, from the author's experiments, that the strength of powder was about 17 tons per square inch. The system of rifling, involving elongated shots without windage, greatly increased the strain on the gun. This being so, it was not surprising that many attempts to rifle the ordinary guns had proved fruitless. Even independent of this extra strain, experience had shown that for heavy ordnance, cast iron was too weak; and it was believed that this was not owing, as had been stated, to any deterioration in the quality of the material, or to any want of honesty on the part of the contractors, but simply to more work being put upon cast iron than it would bear.

Experiments on the direct tensile force of cast iron must not be depended upon, when the material was cast in a huge mass like that of a 68-lb. gun or a 13-inch mortar. Neither could such experiments be trusted as regarded wrought iron or steel. It was shown that the iron cut from the inner part of the Princeton gun was 50 per cent. weaker, as strained by the explosion, than the bar iron from which it was made. The same decrease of strength, though to a less extent,

was found in the case of the great gun forged by the Mersey Iron Company, and presented by them to the country. Moreover, large masses of any metallic substance must always, it was believed, be subject to inequalities of physical structure, which rendered them untrustworthy for heavy ordnance.

These considerations led the author and others to the principle of construction already named. Capt. Blakely and Mr. Mallet sought to apply it by means of hoops, which, under almost any circumstances, gave an increase of strength. If correctly applied, this increase was very considerable, but there were great difficulties in the application. Each hoop was itself subject to the same law as a homogeneous cylinder, and consequently a series of hoops was wanting in that uniformity of strain which was required. It was possible so to adjust the hoops that at the time of explosion the inner surface of each might be equally strained, but the strain on each hoop decreased to the outer surface, so that there was an abrupt change at the junction of any two hoops. Moreover, a very slight error in workmanship would produce a most serious effect. Taking, for instance, an 8-inch gun, constructed of four concentric hoops, the total thickness being $6\frac{1}{2}$ inches, an error of $\frac{1}{50}$-inch in the size of the outer ring would reduce its strength by 43 per cent.

Wire, on the other hand, afforded the greatest possible facility of construction, and the coils might be laid on with the utmost accuracy as regarded tension, and with the same ease and regularity as thread was wound on to a bobbin.

The first series of experiments tried by the author were made with brass cylinders, 1 inch internal diameter and 1-10th inch thick. Into these, various charges of powder were put, and the ends hermetically sealed. The total capacity of these cylinders was 295 grains of powder. One of these cylinders was burst with a charge of 90 grains. Another, exactly similar, but covered with four coils of 1-33 inch steel wire, was uninjured by a charge of 200 grains.

It having been objected, that owing to the brittleness of cast iron it would be impossible to use it in conjunction with wire, cylinders of cast iron of the same size were prepared. Some of them were entirely filled with powder (310 grains), which was then exploded without injury to the cylinder. In this case, the cylinders, which were 1-10th inch thick, were bound round with ten coils of iron wire, No. 21 gauge, or 1-28th inch diameter. The bursting charge, without wire, was 80 grains.

After this, a small gun was made of cast iron, covered with wire. The chase was 3 feet long, and the calibre 3 inches. The cast iron at the breech was $\frac{3}{8}$-inch thick, and decreased to $\frac{3}{4}$-inch at the muzzle. Iron wire 1-16th inch diameter was used, there being twelve coils at the breech, and four coils at the muzzle. The total weight of the gun with its wrought iron trunnion stock, was 3 cwt. With this gun, and an elongated shot weighing $7\frac{1}{2}$ lbs., and with 11 oz. of government cannon powder, a range of upwards of 1500 yards was attained, the elevation being 7°.

Another application of the principle was stated to be to the cylinders of hydraulic presses, and an instance was given of a cylinder of 6 inches internal diameter, made of cast iron ¾-inch thick, and covered with twelve coils of 1-16th inch iron wire. This cylinder was proved up to 6 tons per square inch, when it gave way by the sides shearing off the bottom plate. The cast iron was not shattered, nor was a single coil of the wire injured.

It was stated that these cylinders could be made at one-fourth the weight and at about one-half the cost of the ordinary hydraulic press cylinders; and that their lightness was of great importance when intended for export to South America and other countries where the means of transport for heavy machinery did not exist.

Translated for the Journal of the Franklin Institute.

Methods employed by the Ancients to Move, Haul, or Raise Blocks of unusual Dimensions. Translated by J. BENNETT, C.E.

From Rondelet's "Art of Building."

The immense ruins of the ancient edifices of Egypt bear witness to the taste which the Egyptians had for the grand and durable; the blocks used for their constructions were of enormous size. Herodotus speaks of an edifice which formed a part of the temple of Latona at Buto, whose walls were formed of a single rock 52·8 feet long by as much in height. The ceiling or covering of this edifice was also a single block with 5·28 feet thickness.

In another place he says that Amasis ordered to be transported from the Isle of Eléphantine to the town of Sais, twenty days sail distant, a structure formed of a single block of stone; its exterior length was 27·72 feet by 18·48 wide and 10·56 feet high. The interior measured 24·86 feet in length, by 15·84 in breadth, by 6·6 in height. Two thousand men were employed three years in its transportation.

The mass of this last structure, deducting the empty space within, was 2822 cubic feet, and its weight was 458,744 lbs., on the supposition that the rock was formed of the same granite as the obelisks.

As for the other structure which formed a part of the temple of Latona at Buto, the Greek text of Herodotus seems to describe the four walls as being formed of a single block *hollowed like a trough.* In this case it would have required a block of 147,200 cubic feet, with a weight of 24,260,500 lbs., and supposing it was not transported until after being hollowed, its weight would still have been 9,944,750 lbs.

The transportation of so heavy a mass and of so great volume would appear as an inconceivable difficulty, even by water, on account of the immense size of the vessel or platform required to keep afloat so great a load, which was twenty times that transported by Amasis. The difficulties of unloading and moving upon the ground so great a mass would seem to be insurmountable, as it would not be possible to find machines or rollers strong enough to bear such a weight without crushing. The Count of Carbury, who had charge of the transportation of the rock to St. Petersburg, whose weight was only 3,234,000 lbs.,

said that it was impossible for him to make use of rollers; even iron ones were insufficient. Balls of wrought and cast iron, which he tried to substitute for them, were flattened and broken, as well as the cushions of the same metal, in which these balls rolled; only those made of a mixture of copper, tin, and calamine could resist the pressure. Still, as we cannot contradict a matter which Herodotus says he saw and regarded with wonder, we must believe that the walls of this structure were hollowed out of a mass of rock found upon the spot. *This conjecture is all the more probable, as Herodotus does not mention where this enormous block came from, nor the mode of its transportation.*

As for the stone which formed the upper part of the structure, it is evident that it must have been taken from another block, and that it must have been moved and raised above the walls. It was 52·8 feet long by as many broad, with a depth of 5·28 feet, making, all trimmed, a mass of 14,720 cubic feet, and a weight of 1,984,950 lbs., supposing the stone to be of a mean hardness with that used for most of the temples and for the steps of the pyramids.

A block of such dimensions must have been moved in the same position it was to have when laid. The operation required a plane and solid surface of great extent; and as wood was scarce in Egypt, we may presume, according to what Herodotus said in relation to the great pyramid of Cheops, that in these extraordinary circumstances the custom of the Egyptians was to construct large causeways and inclined planes of cut stone, upon which they hauled the enormous stones which they prided themselves on using for the construction of their edifices. These means, which would be expensive with us, were but a small matter with them, by reason of the great number of men employed upon their works, and the small wages of the laborers, and the insignificant cost of the materials.

When they had to move round and unwrought masses of granite, such as are found in the quarries of Egypt, they were turned over or rolled by the force of men. In many places far distant from the quarries, are found masses of granite whose transportation appears to have been interrupted by some unforeseen causes.

As for the blocks which do not come in this kind of transportation, and whose surfaces were plane, as that which served for the covering of the temple at Buto and the monolithe structure of Amasis, we believe that they made use of rollers and capstans, the most simple and ancient machines, the most powerful and speedy in their effects. To give our ideas upon this, we report the result of an experiment made upon this subject with a cut stone weighing 1165 lbs.

To drag this stone upon a horizontal surface of the same material and coarsely cut required 818 lbs.

The same drawn upon pieces of wood exacted a force of 703 lbs.

The same placed upon a wood platform and drawn upon wood required a force of 654 lbs. But soaping the two surfaces which slid upon each other, there was only needed 196 lbs.

This stone, put upon rollers 3·2 inches diameter and set in motion

upon a surface of the same material, required only a force of 36·68 lbs.; the same rolling upon pieces of wood yielded to an effort of 30 lbs., and when the rollers were put between two pieces of wood 23¾ lbs. sufficed.

It follows from this experiment that to draw a rough stone upon a firm and smooth bottom, there is needed a little over $\frac{2}{3}$ of its weight; the $\frac{3}{5}$, if the surface is of wood; $\frac{5}{9}$, if the movement is made of wood upon wood; and if the two sliding surfaces of wood are soaped, but $\frac{1}{6}$. But if we use rollers placed immediately between the stone and ground there will be required a little over $\frac{1}{3}\frac{1}{2}$ of the weight, and $\frac{1}{4}\frac{1}{0}$ if they roll upon wood; and finally, if they roll between two smooth wooden surfaces there will be needed but about the $\frac{1}{5}\frac{1}{0}$ of the weight.

Still it is proper to remark, that as woods compress under great loads, the rollers made of this material are subject to a change of form, to be crushed, and to sinking in the pieces between which they are placed; this produces a friction, whose effect increases with the load. To raise the obelisk at the square of St. Peter's in Rome, which, with all its fixtures, weighed 829,250 lbs., there were required forty capstans, and to draw it upon a horizontal plane with rollers placed between two wooden surfaces it only needed four; whence it follows in this case that the force was but the $\frac{1}{1}\frac{1}{0}$ part of the weight, while the experiment above cited gives a little over the $\frac{1}{5}\frac{1}{0}$ part. But Fontana, who superintended this operation, observed that most of the rollers, which were 70 in number, were crushed, and that the others sank into the pieces of wood between which they were placed.

To have the full benefit of the rollers they should be as incompressible as the surfaces between which they move. Granite rollers between surfaces of the same material to prevent breaking should be very short, and their number great, to have as little of the load as possible on each. The length should not be over one-and-a-half diameters. When the stone has considerable width they must be set in many rows. This method, if practicable, would have been preferable to the balls, which the Count of Carbury used for the transportation of the rock which served for the base of the equestrian statue of Peter the Great; they required the $\frac{1}{2}\frac{1}{2}$ part of the weight.

From the results of these experiments and the observations to which they give rise, we may calculate the force required to transport the stone which formed the monolithe structure at Saïs, and the covering of the temple at Buto.

Experience with works has taught us that a man of medium strength and used to work like those employed by the ancients can carry a load equal to his weight and haul one-and-a-half times as much, so that for the stone cover of the temple at Buto, whose weight we have estimated at 1,984,950 lbs., there would be required 10,000 men to draw it upon a smooth and solid ground; 9000 to draw it upon a surface formed of pieces of wood; 8333 if the stone was put upon a wood platform and drawn upon wood; and only 2500 men if care was taken to soap the two surfaces which slid upon each other.

The block being 52·8 feet wide, the men could easily be disposed in

forty rows, which for the first case would require 250 in each row, in case they were equal, and much less if they diverged; 225 for the second; 208 for the third; and 62½ for the fourth; the last is the most practicable method.

The great breadth of this stone and its weight would make it impossible to use wooden rollers. As for those of granite, if the ground were firm and smooth enough to make use of them, 300 men or 7½ rows would have sufficed to move the load. But it is not likely that this method was adopted on account of its great expense. It is much more probable that they made use of capstans.

Supposing a simple capstan, traversed by two levers with a mean length at the point of application of the resultant force of ten times the diameter of the drum, each man makes an effort which may be valued at at 539½ lbs. If twelve men work each capstan, their effort will be 6474 lbs., which gives in the first case, when a force equal to ⅔ of load is required, 2400 men and 200 capstans.

For the second case 2160 men and 180 capstans; for the third 2000 men and 166 capstans; and for the fourth 600 men and 50 capstans.

By the use of pulleys and muffles the number of men and capstans may be reduced one-half or a quarter.

The results here shown indicate the force necessary to move the block upon a horizontal plane; but as it had to be raised above the walls of the temple which it served to cover, in raising it upon an inclined plane it is evident that the force must be increased in the ratio of its inclination. We here give upon this subject some experiments which will serve to make known the proportion of the increase of the force.

If we place a square based solid upon a right plane and the surfaces are not polished, more or less difficulty is experienced in moving it, according to the roughness of the surfaces. But if, instead of pushing the body for its motion, we incline the plane until it commences sliding, we find that it requires as much force to move a round body up this incline as to draw the square based solid upon a horizontal plane. Moreover, to haul up the square based solid upon an inclined plane, we must use a force equal to that which would cause a round body to rise upon an inclined plane as many degrees above the plane on which the square based solid began to slide, as the first plane is above the horizontal.

The force required to raise a round body upon an incline is very nearly the same as that given by theory; whence it follows if we take for the horizontal plane, that upon which a plane surface solid begins to slide, we shall have the force necessary to raise this solid upon any incline by adding to its inclination that of the plane taken for the horizontal.

Experiments.—To draw upon a lias slab placed horizontally a cube of the same material, with a face of 4·26 inches weighing 6·74 lbs., it required a force of 3·57 lbs. This cube did not begin to slide until the plane on which it stood was raised a little more than 30°. To

draw up this plane a round body of the same weight and material required 3·52 lbs; the diameter of the body was 4·8 inches.

To draw the above cube upon the same plane inclined 30°, the line of traction being parallel to plane, required a force of 5·95 lbs. This force is sufficient to raise the round body upon a plane inclined 60°.

The force required to raise a round body upon inclines of 30° and 60° is very nearly equal to that given by the application of the principles of mechanics. For, in the first case, theory gives 3·37 lbs. and experiment 3·52.

For the second case theory gives 5·87 lbs., and *experiment* 5·95 lbs.

It follows from these experiments that in taking for the horizontal plane, that upon which a solid with a plane surface begins to slide, we shall find the force required to raise this solid upon any incline, by adding to the inclination of this plane, that of the plane upon which the solid begins to slide. Thus, to make an application of this rule to the great block of Buto, we will suppose the plane for carrying it above the walls was inclined at 12°. This granted, mechanics demonstrates that the force required to raise a round body upon an inclined plane is to its weight, as the height of the plane is to its length; we have found that to draw this stone upon a horizontal plane, in the first case, the necessary force was $\frac{2}{3}$ of the weight; that is to say, it answers to that required to raise a round body upon a plane of 41° 48′, to which adding the 12°, for the slope of plane on which the block is to be raised, we have 53° 48′, whose sine indicates $\frac{4}{5}$ of the weight in place of $\frac{2}{3}$.

In the second case, the force, being $\frac{3}{5}$ of the weight, answers to the sine of 36° 53′, to which adding 12°, we have 48° 53′, whose sine indicates $\frac{3}{4}$ of the weight.

For the third case, the force is $\frac{5}{9}$ of the weight, which answers to sine of 33° 45′, and of 45° 45′ in adding the 12°, whose sine indicates $\frac{7}{10}$ of the weight.

Finally, the fourth case, which exacts but $\frac{1}{6}$ of the weight, answers to the sine of 9° 36′, to which adding the 12° we have 21° 36′, whose sine indicates a force equal to $\frac{2}{25}$ of weight. Thus, by using simple capstans without muffles, there was required, in the first case, to raise the block upon an incline of 12°, 240 capstans and 2880 men.

For the second case, 225 capstans and 2700 men. For the third case, 210 capstans and 2520 men. For the fourth case, 108 capstans and 1296 men.

Making the same applications to the monolithe structure of Amasis, whose weight was 458,744 lbs., we shall find that to draw it without capstans upon a horizontal plane like that of the first case required 2444 men.

For the second case 2200 men; for the third 2037; and for the fourth 611. The description of Herodotus proves that the third method was adopted for transporting this edifice, and that no use was made of rollers or capstans. It appears that the structure was placed upon a platform of carpentry, and drawn upon pieces of wood. The same method was probably used for transporting the obelisk of Rhamesses, spoken of by Pliny, for which 20,000 men were employed. This obe-

lisk weighed 1,618,500 lbs., including its fixtures and the armatures of carpentry required from its great weight to prevent fracture. This process would require more than 7000 men without taking account of those occupied in preparing the roads and machines, which together might require a working force of 10,000 men, and a like number for a relay.

MECHANICS, PHYSICS, AND CHEMISTRY.

*On the Construction and Durability of Steam Boilers.** By Mr. Benjamin Goodfellow, of Hyde.

The object of this paper is to communicate some circumstances and changes that have been observed by the writer to take place in the size and form of boilers at different temperatures, which affect considerably their strength and durability, by causing derangement and wear and tear to a much greater extent than he believes is generally supposed. His attention was first strongly drawn to this subject some years ago in reference to a large multitubular boiler that he constructed, 23 feet long and 6½ feet diameter, with 131 tubes, 11 feet long and 3 inches diameter each; and two similar boilers, but of smaller dimensions, with 9 feet tubes. A short time after these had been put to work, it was found that several of the tubes began to leak at both ends, although they had previously been proved up to 120 lbs. per square inch with water pressure, when all was good and tight, and the steam pressure they worked at was only from 50 to 55 lbs. After this leakage had been made good, it took place again in a few weeks; and this was repeated several times, both in the large and small boilers, but not to the same extent in the small ones. This led the writer to conclude that the cause was the elongation of the tubes by their being heated to a greater extent than the casing of the boiler; and this defect appears to him a serious objection in multitubular boilers with straight tubes of considerable length.

In the construction of fluid boilers of considerable length, say from 20 to 36 feet long, the writer at first adopted the plan of increasing the diameter of the flue, so as to increase the heating surface and diminish the quantity of water; bringing the flues nearer to each other, in the case of the two-flued boiler, and closer to the sides of the boiler, by making their diameter as large as could be got in. After a number of these had been got to work, several of them gave way transversely about the middle seam at the bottom, especially in cases where the boiler had been blown off for cleaning and cold water then turned in to cool it; the effect of which was that the bottom of the boiler instantly contracted in length, while the flues retained the same length, or nearly so, as when working, until the water came in contact with them, thereby necessarily throwing a great and undue strain upon every seam of the boiler, especially on the lower side, in consequence

* From Newton's London Journal, August, 1860.

of the flues being so near the bottom of the boiler. The writer therefore concluded that it was wrong to increase the diameter of the ends of the flues, as this rendered the ends of the boiler much more rigid and less yielding to the expansion and contraction of the flues and casing, which do not take place in both simultaneously or to the same extent. In a boiler 30 feet long, the actual expansion of the barrel of the boiler amounts to nearly 1 inch in length; and when fired in the flue, the latter is elongated ¼ inch more than the casing, in consequence of its being at so much higher a temperature. The evil effects of this expansion and contraction are further augmented by the ordinary use of gusset stays, by which the ends of the boiler are stiffened and rigidly connected to the barrel. The circumstance of the boilers giving way in the middle of their length rather than in any other part, was owing, in the writer's opinion, to their being supported on a longitudinal centre wall, which divided the flues, or on two walls; when full of water, the boiler would weigh from 38 to 40 tons, and consequently there would be a great friction on the wall when the boiler was contracting; and the strain thus produced in pulling the two ends of the boiler nearer together is concentrated at the middle of its length, in addition to the strain arising from the resistance occasioned by the rigidity of the flues and gusset stays.

In order to obviate these difficulties in flued boilers, and to provide for expansion and contraction taking place without much injury to the material or workmanship, the writer has been led to adopt flues with tapered ends, which give a greater amount of elasticity to the ends of the boiler; and with the same view, the gusset stays are dispensed with, so that the ends are not connected in any way with the casing, except by an angle-iron ring that unites the two together. The same plan may be carried out in a single-flued boiler, either by tapering the ends of the flue, or placing it nearer the centre of the boiler. The ends of the boiler are strengthened independently by means of T iron or "fish-back" girders riveted on each end between the casing and the flues; and there are no longitudinal stays between the two ends beyond those supplied by the flues and casing, each end plate being treated as an independent transverse girder supported round its edge. In order to strengthen the bottom of the boiler at the middle, against the strain produced in contracting by the friction of the longitudinal walls on which it is supported, two longitudinal strips of angle-iron or T iron are riveted on the inside, at about 3 feet apart, extending about two-thirds the length of the boiler. The writer has also adopted for some time a plan of strengthening flues of large diameter against collapse, by means of rings of T iron or angle-iron, riveted at suitable intervals round the outside of the flue at the joints. In these joints the two ends of the boiler plates are not brought together, but are left with a space between them equal to the thickness of the outer rib of the T iron, whereby a joint is obtained having no greater thickness of metal than a double plate at any part.

The absence of longitudinal and gusset stays in this construction of

boiler does not leave the ends less strong to resist explosion than the other parts of the casing: for taking the whole circumference of both flues and casing, the sectional area of plate resisting the pressure on the ends of the boiler is $4\frac{3}{4}$ times greater than that resisting the lateral pressure in the casing; and in the upper half of the ends, where the pressure acts upon the greatest proportionate area, producing the greatest longitudinal tension, the resistance is $3\frac{1}{2}$ times that offered to lateral explosion; while in the lower half of the ends, where there is the least proportionate area for the pressure to act upon, the resistance is $6\frac{1}{2}$ times greater than the lateral resistance. The fact that flued boilers generally explode endways by failure of the lower part of the ends or casing—the very part which has been seen to be originally the strongest—proves that the strength of the plates at that part becomes greatly injured by the excessive strains arising from unequal expansion and contraction of the flues and the casing of the boiler.

Mr. R. B. Longridge could confirm the observations made in the paper as to the frequent injury caused to boilers by the effects of unequal strains upon different portions; but he did not agree with the opinion expressed that the construction of boiler proposed would be free from this source of injury. There was no doubt that great mischief arose in many boilers from imperfect circulation of the water. If perfect circulation could be obtained, a uniform temperature throughout the boiler would be preserved, and these evils obviated. In two-flued boilers, generally, it was a great defect that the water spaces were made exceedingly small, and the descent of the water past them was opposed by the rising current from the heated sides of the flues; so that the only place where the water could descend was at the back end, where coolest; and in a boiler of 30 feet length this downward current was not able to reach the front end. Plates had been put into the boiler sometimes, to divert the currents of water, and cause more regularity of circulation, but he doubted whether with much success. When a couple of 3 feet flues were put into a 7 feet boiler, 3 inch water spaces only could be obtained; and although there was no doubt a better combustion in a large flue, yet this involved the sacrifice of the proper width of water space for insuring due circulation in the boiler, which was a point of greater importance.

He did not agree with the mode proposed for staying boilers, and did not think it was at all advisable to dispense with both longitudinal and gusset stays; he considered that the end should not be left dependent only upon the riveting to the cylindrical shell and the flues. The girder ends of the boiler would no doubt be strong enough so long as the flues held good; but if the flues got seriously overheated at any part and fracture ensued, which was an accident that could not be absolutely guarded against, the boiler end might then give way on losing the support of the flues. In the case of boilers set upon a centre bearing wall, he did not see how the friction upon the bearing could cause such strain in expanding and contracting as sensibly to

affect the durability of the plates; but the best plan of setting such boilers he considered was to support them upon cast iron saddles, in such a manner as not to be dependent for support on the brickwork forming the flues. An objectionable action was caused when the fire was not placed in the boiler flues, but below the boiler, for in that case there was a continued current rising at the sides, causing a descending current in the middle between the two flues, which made the deposit all accumulate in the triangular space between the flues and immediately over the fire: in many such cases, the plates over the fire became overheated in consequence, and fractured or strained at the joints.

Mr. Goodfellow considered the mode of fixing boilers on cast iron saddles was very good, and preferred it where a centre wall was not required for division between the flues. In respect of securing the boiler ends, he remembered a case where the end plates were increased from $\frac{1}{2}$ to $\frac{3}{4}$ inch thickness, on account of the boiler leaking at the ends; but the bottom had then torn asunder, and he had suggested tapering the ends of the flues to a smaller diameter, so as to increase the area of flat plate at the boiler end, and substituting a thinner plate, for the purpose of getting more elastic action in the end plate; this had entirely removed the difficulty, and the boiler had continued at work for $1\frac{1}{2}$ years since then, without any failure. He had found, by carefully measuring the end of a two-flued boiler, 28 feet long, that the front end plate was pushed outwards $\frac{1}{8}$ inch in the centre, making it convex, each time the steam was up, and it gradually came back again on the boiler cooling; the back end of the boiler was not accessible for measurement, being within the brickwork, but both ends must have sprung nearly alike in order to cause the bulging, making altogether $\frac{1}{4}$ inch alternation in length of the flue, constantly going on in the working of the boiler. It appeared to him, then, that as this action could not be prevented, it was the best course to allow the end plates to yield to it, by leaving them elastic, and not hindering them from springing.

Mr. H. W. Harman said, that from his experience as chief inspector to the Manchester Association for the prevention of boiler explosions, he knew of no better construction than the cylindrical two-flued boiler, which was the one in most general use; but it was undoubtedly subject to the derangements pointed out in the paper, from the effects of unequal expansion and contraction. An unequal strain was caused upon the end angle-iron of the boiler from the flues being attached to the end plate so much below the centre; he had found many fractures of the end plates immediately over the angle-irons of the internal flues, caused principally by the end plates not yielding sufficiently to the elongation of the flues. There was no doubt that, if the plate were held too rigidly by gusset stays, something would have to give way to the inevitable strain from expansion; but he could not agree at all with the plan proposed of dispensing altogether with gusset and longitudinal stays. The entire omission of stays would be the opposite extreme, and he thought they ought not to be abandoned without

substituting something else; the angle-iron which would then form the only tie between the end plate and shell, was unavoidably a comparatively weak form of iron from the mode of its rolling, and he feared, if such a plan were adopted, great risk of accident from inferior quality of angle-iron would ensue. He had examined boilers that had exploded, in which the whole of the angle-iron had parted along the upper portion of the boiler end.

As to the strain along the bottom of the shell, he had found the addition of T iron strips along the bottom did not prevent this, and he believed it arose entirely from want of circulation in the water. The plan of a centre wall dividing the flue, with the boiler resting upon it, he considered objectionable; for any leakage of water trickled down to that point, and was absorbed by the centre wall like a sponge, acting as a constant source of corrosion to the boiler.

Imperfect circulation of water formed, he believed, the most serious defect in boilers; and in many of the two-flued boilers this was chiefly owing to their not having a sufficient water space between the flues and shell. He had long been convinced of the importance of insuring a much better circulation of water being regularly maintained in boilers; and he contemplated effecting this by direct mechanical means.

Mr. D. Adamson thought it was certainly advisable to have the gusset stays for support to the end plates of a boiler, and he did not see that any thing could be gained by transferring all the action to one joint; but, on the contrary, there was this important disadvantage to be considered—that if a plate were bent backwards and forwards continually, it might fail ultimately, though not subjected at any one time to too severe a strain; if all the buckling action were thrown on the end plate, it would be simply a question of time as to its ultimate failure. On that account, he thought gusset stays should not be abandoned, and they served also as a good support against collapse; he should also recommend longitudinal stays to be retained in addition, for relieving the strain upon the boiler end joints and the circular seams of the boiler shell.

The Chairman said, he had two-flued boilers at his works, that had been in constant use for fifteen years, and no repairs had been wanted to them yet, and he had found them completely satisfactory; but then he never used angle-iron in the construction of such boilers, considering there was not space enough for the plate to spring with the additional thickness of the angle-iron. The plates of the shell, and the flues, were all flanched over at the ends for riveting to the end plates, requiring, of course, best material for the plates; the water spaces he made never less than 6 inches, and preferred 8 inches; this construction gave great flexibility to the ends of the boiler, and there was no danger of failure, he believed, until the boiler was actually worn out with age.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. FARADAY, D. C. L., F. R. S.

LECTURE V. (Jan. 6, 1860.)—*Magnetism.—Electricity.*

I wonder whether we shall be too deep to-day or not. Remember, that we spoke of the attraction by gravitation of *all* bodies to all bodies by their simple approach. Remember, that we spoke of the attraction of particles of the *same* kind to each other,—that power which keeps them together in masses,—iron attracted to iron, brass to brass, or water to water. Remember, that we found, on looking into water, that there were particles of two different kinds attracted to each other; and this was a great step beyond the first simple attraction of gravitation; because here we deal with attraction between *different* kinds of matter. The hydrogen could attract the oxygen and reduce it to water, but it could not attract any of its own particles, so that there we obtained a first indication of the existence of *two* attractions.

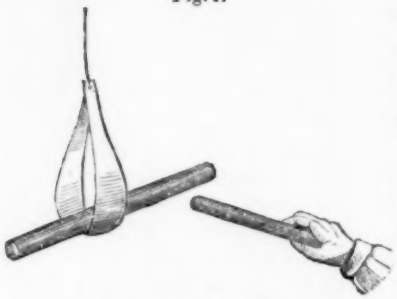
To-day we come to a kind of attraction even more curious than the last, namely, the attraction which we find to be of a double nature—of a curious and dual nature. And I want first of all to make the nature of this doubleness clear to you. Bodies are sometimes endowed with a wonderful attraction, which is not found in them in their ordinary state. For instance, here is a piece of shellac, having the attraction of gravitation, having the attraction of cohesion, and if I set fire to it, it would have the attraction of chemical affinity to the oxygen in the atmosphere. Now all these powers we find *in* it as if they were parts of its substance; but there is another property which I will try and make evident by means of this ball, this bubble of air [a light india-rubber ball, inflated and suspended by a thread]. There is no attraction between this ball and this shellac at present; there may be a little wind in the room slightly moving the ball about, but there is no attraction. But if I rub the shellac with a piece of flannel [rubbing the shellac, and then holding it near the ball], look at the attraction which has arisen out of the shellac, simply by this friction, and which I may take away as easily by drawing it gently through my hand. [The Lecturer repeated the experiment of exciting the shellac, and then removing the attractive power by drawing it through his hand.] Again you will see I can repeat this experiment with another substance; for if I take a glass rod and rub it with a piece of silk covered with what we call amalgam, look at the attraction which it has, how it draws the ball towards it; and then, as before, by quietly rubbing it through the hand, the attraction will be all removed again to come back by friction with this silk.

But now we come to another fact. I will take this piece of shellac, and make it attractive by friction; and remember that whenever we get an attraction of gravity, chemical affinity, adhesion, or electricity (as in this case), the body which attracts is attracted also, and just

* From the Lond. Chemical News, No. 9.

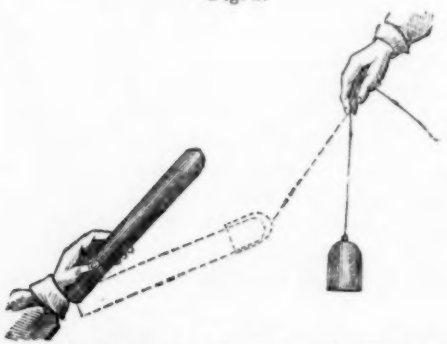
as much as that ball was attracted by the shellac, the shellac was attracted by the ball. Now I will suspend this piece of excited shellac in a little paper stirrup, in this way (Fig. 1), in order to make it move easily, and I will take another piece of shellac, and after rubbing it with flannel, will bring them near together: you will think that they ought to attract each other, but now what happens? It does not attract; on the contrary, it very strongly *repels*, and I can thus drive it round to any extent. These therefore, repel each other, although they are so strongly attractive—repel each other to the extent of driving this heavy piece of shellac round and round in this way. But if I excite this piece of shellac as before, and take this piece of glass and rub it with silk and then bring them near, what think you will happen? [The Lecturer held the excited glass near the excited shellac, when they attracted each other strongly.] You see, therefore, what a difference there is between these two attractions,—they are actually two *kinds* of attraction concerned in this case, quite different to any thing we have met with before; but the *force* is the same. We have here then a double attraction—a dual attraction or force—one attracting and the other repelling.

Fig. 1.



Again, to show you another experiment which will help to make this clear to you. Suppose I set up this rough indicator again [the excited shellac suspended in the stirrup]; it is rough, but delicate enough for my purpose; and suppose I take this other piece of shellac, and take away the power, which I can do by drawing it gently through the hand; and suppose I take a piece of flannel (Fig. 2) which I have

Fig. 2.



shaped into a cap for it, and made dry. I will put this shellac into the flannel, and here comes out a very beautiful result. I will rub this shellac and the flannel together (which I can do by twisting the shellac round), and leave them in contact; and then if, I ask, by bringing them near our indicator, what is the attractive force? it is nothing! But if I

take them apart, and then ask what will they do when they are separated,—why the shellac is strongly repelled, as it was before, but the cap is strongly attractive; and yet if I bring them both together again, there is no attraction—it has all disappeared [the experiment was repeated]. Those two bodies therefore still contain this attractive power—when they were parted it was evident to your senses that they had it, though they do not attract when they are together.

This, then, is sufficient in the outset to give you an idea of the nature of the force which we call ELECTRICITY. There is no end to the things from which you can evolve this power. When you go home take a stick of sealing-wax—I have rather a large stick, but a smaller one will do—and make an indicator of this sort (Fig. 3). Take a watch-glass (or your watch itself will do, you only want something which shall have a round face), and now if you place a piece of flat glass upon that, you have a very easily moved centre; and if I take this lath and put it on the flat glass (you see I am searching for the centre of gravity of this lath, I want to balance it upon the watch-glass), it is very easily moved round, and if I take this piece of sealing-wax and rub it against my coat, and then try whether it is attractive [holding it near the lath], you see how strong the attraction is; I can even draw it about. Here, then, you have a very beautiful indicator, for I have with a small piece of sealing-wax and my coat pulled round a plank of that kind, so you need be in no want of indicators to discover the presence of this attraction. There is scarcely a substance which we may not use. Here are some indicators (Fig. 4). I bend round a strip of paper into a hoop and we have as good an indicator as can be required; see how it rolls along, traveling after the sealing-wax. If I make them smaller, of course we have them running faster, and sometimes they are actually attracted up into the air. Here also is a little collodion balloon. It is so electrical that it will scarcely leave my hand unless to go to the other. See how curiously electrical it is; it is hardly possible for me to touch it without making it electrical; and here is a piece which clings to any thing it is brought near, and which it is not easy to lay down. And here is another substance, gutta-percha, in thin strips; it is astonishing how by rubbing this in your hands you make it electrical; but our time forbids us to go farther into this subject at present; you see clearly there are two kinds of electricities which may be obtained by rubbing shellac with flannel or glass with silk.

Fig. 3.

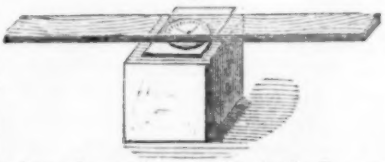


Fig. 4.

Now there are some curious bodies in nature (of which I have two specimens on the table) which are called *magnets* or *loadstones;* ores of iron, of which there is a great deal sent from Sweden. They have the attraction of gravitation, and attraction of cohesion, and certain

chemical attraction; but they also have a great attractive power, for this little key is held up by this stone. Now, that is not chemical attraction, it is not the attraction of chemical affinity, or of aggregation of particles, or of cohesion, or of electricity (for it will not attract this ball if I bring it near it), but it is a separate and dual attraction, and what is more, one which is not readily removed from the substance, for it has existed in it for ages and ages in the bowels of the earth. Now we can make artificial magnets (you will see me to-morrow make artificial magnets of extraordinary power). And let us take one of these artificial magnets, and examine it, and see where the power is in the mass, and whether it is a dual power. You see it attracts these keys, two or three in succession, and it will attract a very large piece of iron. That then is a very different thing indeed to what you saw in the case of the shellac, for *that* only attracted a light ball, but here I have several ounces of iron held up. And if we come to examine this attraction a little more closely, we shall find it presents some other remarkable differences; first of all, one end of this bar (Fig. 5) attracts this key, but the middle does not attract. It is not then the *whole* of the substance which attracts. If I place this little key in the middle it does not adhere; but if I place it *there*, a little nearer the end, it does, though feebly. Is it not then very curious to find that there is an attractive power at the extremities which is not in the middle?—to have thus in one bar two places in which this force of attraction resides. If I take this bar and balance it carefully on a point so that it will be free to move round, I can try what action this piece of iron has on it. Well, it attracts one end, and it also attracts the other end, just as you saw the shellac and the glass did, with the exception of its

Fig. 5.

Fig. 6.

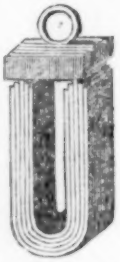
not attracting in the middle. But if now, instead of a piece of iron, I take a *magnet*, and examine it in a similar way, you see that one of its ends *repels* the suspended magnet; the force then is no longer attraction but repulsion; but, if I take the other end of the magnet and bring it near, it shows attraction again.

You will see this better, perhaps, by another kind of experiment. Here (Fig. 6) is a little magnet, and I have colored the ends differently so that you may distinguish one from the other. Now this end (. . . .) of the magnet (Fig. 5) attracts the *uncolored* of the little magnet. You see it pulls it towards it with great power. And as I carry it round, the uncolored end still follows. But now if I gradually bring the middle of the bar magnet opposite the uncolored end of the needle, it has no effect upon it, either of attraction or repulsion, until,

as I come to the opposite extremity (. . . .) you see that it is the *colored* end of the needle which is pulled towards it. We are now therefore dealing with two kinds of power, attracting different ends of the magnet—a double power, already existing in these bodies, which takes up the form of attraction and repulsion. And now when I put up this label with the word MAGNETISM, you will understand that it is to express this double power.

Now with this loadstone you may make magnets artificially. Here is an artificial magnet (Fig. 7) in which both ends have been brought together in order to increase the attraction. This mass will lift that lump of iron, and what is more, by placing this *keeper*, as it is called, on the top of the magnet, and taking hold of the handle, it will adhere sufficiently strongly to allow itself to be lifted up, so wonderful is its power of attraction. If you take a needle, and just draw one of its ends along one extremity of the magnet, and then draw the other end along the other extremity, and then gently place it on the surface of some water (the needle will generally float on the surface, owing to the slight greasiness communicated to it by the fingers), you will be able to get all the phenomena of attraction and repulsion, by bringing another magnetized needle near to it.

Fig. 7.



I want you now to observe that although I have shown you in these magnets that this double power becomes evident principally at the extremities, yet the *whole* of the magnet is concerned in giving the power.

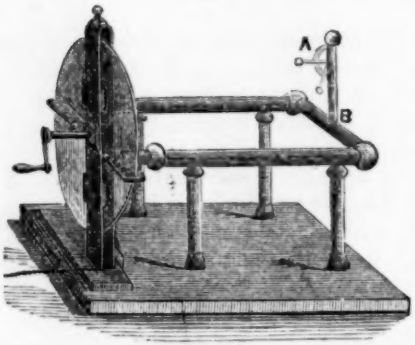
That will at first seem rather strange, and I must therefore show you an experiment to prove that this is not an accidental matter, but that the whole of the mass is really concerned in this force, just as in falling the whole of the mass is acted upon by the force of gravitation. I have here (Fig. 8) a steel bar, and I am going to make it a magnet by rubbing it on the large magnet (Fig. 7). I have now made the two ends magnetic in opposite ways. I do not at present know one from the other, but we can soon find out. You see when I bring it near our magnetic needle (Fig. 6) one end repels and the other attracts; and the middle will neither attract nor repel—it *cannot*, because it is *half-way between the two ends*. But now, if I break out that piece (*n. s.*) and then examine it—see how strongly one end (*n*) pulls at this end (S, Fig. 6) and how it repels the other end (N). And so it can be shown that every part of the magnet contains this power of attraction and repulsion, but that the power is only rendered evident at the end of the mass. You will understand all this in a little while, but what you have now to consider is that every part of this steel is in itself a magnet. Here is a little fragment which I have broken out of the very centre of the bar, and you will still see that one end is attractive and the other is repulsive. Now, is not this power a most wonderful thing? And very strange, the means of taking it from one substance and bringing it to other matters. I cannot make a piece of iron or any thing else heavier or lighter than it is; its cohesive power

Fig. 8.

it must and does have; but as you have seen by these experiments, we can add or subtract this power of magnetism, and almost do as we like with it.

And now we will return for a short time to the subject treated of at the commencement of this lecture. You see here (Fig. 9) a large machine got up for the purpose of rubbing glass with silk and for obtaining the power called *electricity;* and the moment the handle of the machine is turned a certain amount of electricity is evolved, as you will see by the rise of the little straw indicator (. . . .). Now I know from the appearance of repulsion of the pith ball at the end of the straw that the electricity is present in those brass conductors (. . . .), and I want you to see the manner in which that electricity can pass away [touching the conductor (. . .) with his finger, the Lecturer drew a spark from it, and the straw electrometer immediately fell]. There, it has all gone; and that I have really taken it away you shall see by an experiment of this sort. If I hold this cylinder of brass by the glass handle and touch the conductor with it I take away a little of the electricity. You see the spark in which it passes, and observe that the pith ball indicator has fallen a little, which seems to imply that so much electricity is lost; but it is not lost, it is here in this brass, and I can take it away and carry it about, not because it has any substance of its own, but by some strange property which we have not before met with as belonging to any other force. Let us see whether we have it here or not. [The Lecturer brought the charged cylinder to a jet from which gas was issuing; the spark was seen to pass from the cylinder to the jet, but the gas did not light.] Ah! the gas did not light, but you saw the spark; there is perhaps some draft in the room which blew the gas on one side, or else it would light; we will try this experiment afterwards. You see from the spark that I can transfer the power from the machine to this cylinder, and then carry it away and give it to some other body. You know very well as a matter of experiment that we can transfer the power of heat from one thing to another; for if I put my hand near the fire it gets hot. I can show you this by placing before us this ball which has just been brought red-hot from the fire. If I press this wire to it some of the heat will be transferred from the ball, and I have only now to touch this piece of gun-cotton with the hot wire and you see how I can transfer the heat from the ball to the wire and from the wire to the cotton. So you see that some powers are transferable and others are not. Observe how long the heat stops in this ball. I might touch it with the wire, or with my finger, and if I did so quickly, I should merely burn the surface of the

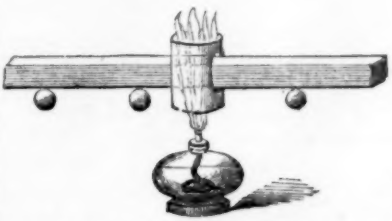
Fig. 9.



skin; whereas if I touch that cylinder however rapidly with my finger the electricity is gone at once—dispersed on the instant, in a manner wonderful to think of.

I must now take up a little of your time in showing you the manner in which these powers are transferred from one thing to another; for the manner in which *force* may be conducted or transmitted is extraordinary, and most essential for us to understand. Let us see in what manner these powers travel from place to place. Both heat and electricity can be conducted; and here is an arrangement I have made to show how the former can travel. It consists of a bar of copper (Fig. 10), and if I take a spirit-lamp (this is one way of obtaining the power of heat) and place it under that little chimney, the flame will strike against the bar of copper and keep it hot. Now you are aware that power is being transferred from the flame of that lamp to the copper, and you will see by-and-by that it is being conducted along the copper from particle to particle; for, inasmuch as I have fastened these wooden balls by a little wax at particular distances from the point where the copper is first heated, first one ball will fall and then the more distant ones, as the heat travels along, and thus you will learn that the heat travels gradually through the copper. You will see that this is a very slow conduction of power as compared with electricity. If I take cylinders of wood and metal joined together at the ends and wrap a piece of paper round and then apply the heat of this lamp to the place where the metal and wood join, you will see how the heat will accumulate where the wood is, and burn the paper with which I have covered it; but where the metal is beneath the heat is conducted away too fast for the paper to be burned. And so if I take a piece of wood and a piece of metal joined together, and put it so that the flame shall play equally both upon one and the other, we shall soon find that the metal will become hot before the wood; for if I put a piece of phosphorus on the wood, and another piece on the copper, you will find that the phosphorus on the copper will take fire before that on the wood is melted; and this shows you how badly the wood conducts heat. But with regard to the traveling of electricity from place to place its rapidity is astonishing. I will, first of all, take these pieces of glass and metal, and you will soon understand how it is that the glass does not lose the power which it acquired when it is rubbed by the silk; by one or two experiments I will show you. If I take this piece of brass and bring it near the machine, you see how the electricity leaves the latter and passes to the brass cylinder. And again, if I take a rod of metal and touch the machine with it I lower the indicator, but when I touch it with a rod of glass no power is drawn away, showing you that the electricity is conducted by the glass and the metal in a manner entirely different; and to make you see that

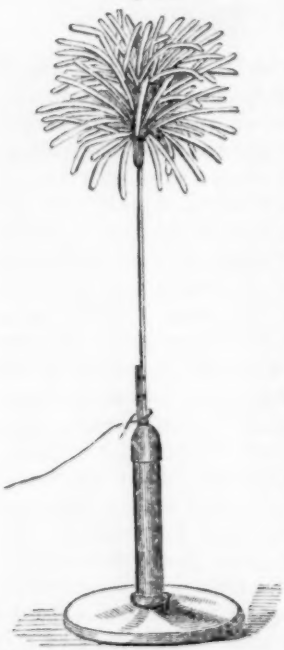
Fig. 10.



more clearly we will take one of our Leyden jars. Now, I must not embarrass your minds with this subject too much, but if I take a piece of metal and bring it against the knob at the top and the metallic coating at the bottom you will see the electricity passing through the air as a brilliant spark. It takes no sensible time to pass through this, and if I were to take a long metallic wire, no matter what the length, at least as far as we are concerned; and if I make one end of it touch the outside and the other touch the knob at the top—see how the electricity passes!—it has flashed instantaneously through the whole length of this wire. Is not this different from the transmission of heat through this copper bar (Fig. 10), which has taken a quarter of an hour or more to reach the first ball?

Here is another experiment, for the purpose of showing the conductibility of this power through some bodies and not through others. Why do I have this arrangement made of brass? [pointing to the brass work of the electrical machine, Fig. 9.] Because it conducts electricity. And why do I have these columns made of glass? Because they obstruct the passage of electricity. And why do I put that paper tassel (Fig. 11) at the top of the pole, upon a glass rod, and connect it with this machine by means of a wire? You see at once that as soon as the handle of the machine is turned the electricity which is evolved travels along this wire and up the wooden rod, and goes to the tassel at the top, and you see the power of repulsion with which it has endowed these strips of paper, each spreading outwards to the ceiling and sides of the room. The outside of that wire is covered with gutta percha; it would not serve to keep the force from you if you touched it with your hands, because it would burst through, but it answers our purpose for the present. And so you see how easily I can manage so as to send this power of electricity from place to place by choosing the materials which can conduct the power. Suppose I want to fire a portion of gunpowder, I can readily do it by this transferable power of electricity. I will take a Leyden jar, or any other arrangement which gives us this power, and arrange wires so that they may carry the power to the place I wish; and then placing a little gunpowder on the extremities of the wires, the moment I make the connexion by this discharging rod, I shall fire the gunpowder [the connexion was made and the gunpowder ignited]. And if I were to show you a stool like this, and were to explain to you its construction, you could easily understand that we use glass legs because these are capable of preventing the electricity from going away

Fig. 11.



to the earth. If, therefore, I were to stand on this stool and receive the electricity through this conductor I could give it to any thing that I touched. [The Lecturer stood upon the insulating-stool and placed himself in connexion with the conductor of the machine.] Now I am electrified, I can feel my hair rising up as the paper tassel did just now. Let us see whether I can succeed in lighting gas by touching the jet with my finger. [The Lecturer brought his finger near a jet from which gas was issuing, when after one or two attempts the spark which came from his finger to the jet, set fire to the gas.] You now see how it is that this power of electricity can be transferred from the matter in which it is generated, and conducted along wires and other bodies, and thus be made to serve new purposes utterly unattainable by the powers we have spoken of on previous days; and you will not now be at a loss to bring this power of electricity into comparison with those which we have previously examined, and to-morrow we shall be able to go farther into the consideration of these transferable powers.

(To be Continued.)

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*Steam Boiler Explosions.** By J. W. Clare, C. E.

I have devoted considerable attention for many years to the causes of steam boilers exploding, and in collecting data to form more definite rules to judge of their strength and capabilities. It is a fact not generally known, that boiler breakers are much better acquainted with the causes of steam boiler explosions than boiler makers, and it should be more generally known by the public that there is no mystery whatever in the case, but that they arise simply from causes that may easily be avoided or prevented. Some eighteen years since, I came to the conclusion that, as medical men obtained an insight as to the causes of diseases in the human system during life, by dissecting and examining the body after death, I would adopt the same plan with old steam boilers of all classes, and especially those which had exploded, to arrive at better remedies for their general defects and weakness. With this view, I have repeatedly scraped off the rust from several places on the outside, and the scale also from the inside, of all descriptions of old steam boilers, and then watched their being broken up, and examined the plates afterwards; and from this experience, combined with general observation at various boiler makers, and of a large number in use, I have formed the following conclusions:—

First, from the competition among boiler makers to undersell each other a great deal of plate and angle-iron has been used in the construction of boilers that is quite unfit for the purpose; for all boiler iron should be effectually piled different ways before being placed in the furnace, to ensure the fibre or grain of the iron extending in all directions in the plane of the surface.

Secondly, that punching out one-third of the iron down the sides of the plates, with the grain of the metal, driving into these holes a

* From the London Engineer, No. 235.

steel drift, to force them opposite to each other, and then driving the inner edge of the plate under with steel caulking irons, all tends to granulate and strain the metal left between the rivets. Whereas, if the holes were all drilled through both the plates at once, and arranged to form a double zigzag line, and a slip of spun yarn and white lead, or other suitable packing, laid in between the two lines of rivets, much less caulking would be sufficient, and these joints, and consequently the whole boiler, could be more securely depended upon. And as by inspecting the plates we could form more correct opinions as to the strength of boilers than we can by the present plan of putting them together, I have continually found the metal between the holes so much deteriorated, that sharp blows with a sledge-hammer would split several of them into each other; and I have carefully sawn out thin strips of the metal from between the holes and compared them with similar pieces from other parts of the same plate, and invariably found the metal from between the holes was more brittle than any other. And I have always found that where plates had been drilled and bolted on with bolts and nuts for patches on old boilers, the metal between the holes was not injured. I have also found, that where patches were riveted on and caulked, the metal between the holes in the boiler was much more deteriorated than that between the holes of the patch; and from this I have inferred, that after boiler-paltes have been acted upon by heat and oxidation they will not bear being hammered without greatly reducing their power of adhesion along the line over which the hammer has been used.

Thirdly, many large boilers are worked up to a higher pressure than formerly, in proportion to their weight and strength, being hard fired to a power beyond their capabilities. When do we hear of a steam boiler exploding among the hundreds of small boilers used by shopkeepers and others in a small way of business, who have not sufficient work to strain them?

Fourthly, many manufacturers use their boilers too long a time for safety; I have frequently seen different parts of plates in old boilers, less than one-eighth of an inch thick, and in other cases the metal of the plates so perished, as not to bear being bent to a greater angle than 30 deg. without fracture. From this I argue that while the strain upon a boiler-plate continues in one direction, it may be worked until worn to within one-half its original thickness without risk of explosion at the usual working pressure; but that if any thing occurs to bend or twist the grain of the metal, either by hammering, unequal expansion or contraction, or any other cause, the limit of elasticity is so greatly reduced as to render it incapable to withstand the usual direct strain. And lastly, boilers frequently leak unperceived into one of the flues, and oxidation goes on more rapidly than usual. I will pass over such causes as malconstruction, negligence, wilfulness, &c., and merely observe, in conclusion, that if all persons were compelled to inform a competent surveyor when they fixed a new boiler, and it was his duty to go and examine it, keep an account of the date, and have the power of condemning it if unsafely constructed, as also the

power to go and examine it whenever he thought proper, and of condemning it when it was worn or had become dangerous to public safety: the users of steam boilers might in time be taught that it was entirely to their own interest to have a boiler of the best material and the best construction, such boilers being ultimately, when all expenses are considered, invariably the least expensive.

2, Surrey-square, S. E., June 20, 1860.

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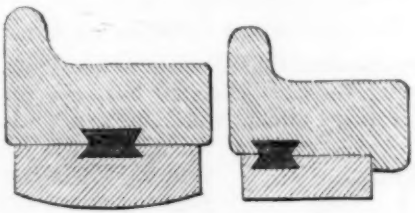
*Fastening Railway Wheel Tires.** By J. C. Pearce.

The consequences resulting from the ordinary defective method of fastening the tires of railway wheels having again recently drawn some attention to the subject, induces me to offer to your notice a new plan, patented some two years ago by Mr. E. Turner, of the Bowling Iron Company, in conjunction with myself, which, though but comparatively little known, is unquestionably the most perfect fastener in use. It presents no difficulties to be overcome in the formation of the tire and wheel-rim, neither is its application confined to any particular section of tire, &c.; but, on the contrary, its simplicity renders it easily applied to all.

A dovetailed groove is formed around the inner surface of the tire, corresponding with a similar groove formed around the wheel-rim, as shown in the accompanying illustrations. The tire, after being shrunk on the wheel in the usual way, is turned and finished so as to allow ample opportunity for the detection of bad welding or other imperfec-



tion. The wheel is then placed in an horizontal position, and the double dovetailed ring is cast into the grooves through holes, similar to rivet holes, in the wheel-rim. The ring thus formed constitutes a continuous rivet all round the wheel, holding both rim and tire firmly together, and rendering it impossible for the latter to get out of position in the event of fracture.

The plan here described is applied to engine and carriage wheels, and has been in successful operation more than two years. Various interests and prejudices will doubtless delay its general adoption, but it is gradually working its way into favor.

There should be no excuse to shield railway companies from the responsibility of accidents arising from the fracture of wheel tires while they possess the means of rendering such accidents perfectly harmless, if not impossible.

July 16, 1860.

* From the Lond. Mechanics' Mag., July, 1860.

Determination of Organic Matter in Water.

M. Emile Monnier presented to the Academy of Sciences of Paris, an interesting note on the determination of the organic matters in the waters of the Seine. The re-agent which he employs is the per-manganate of potassa. The weight of this salt decomposed being sensibly proportional to that of the organic matter, the problem is reduced to the determination of the weight of per-manganate decolored by a given quantity of the water.

The test-liquor which he employs is prepared by dissolving one gramme of pure per-manganate in one litre of distilled water; each cubic centimetre of this liquid contains one milligramme of the salt. To perform an analysis proceed as follows:

Pour into a matrass a half-litre (about a pint) of the water and bring it to the temperature of 158° F.; add through a pipette 1 cubic centimetre of pure sulphuric acid; then add the test-liquor until a permanent coloration is produced; the number of cubic centimetres of this liquor added, gives at once in milligrammes the weight of the re-agent decomposed by one litre of water. At about 158° F. the decomposition of the organic matters is rapid; at common temperatures it would require more than 24 hours to be complete.

The sensibility of the per-manganate is very great; one gramme of tannin in 2 cubic metres (or one part of tannin to two million parts of water) and even one part by weight of sulphuretted hydrogen in eleven million parts of water will discolor it.—*Cosmos.*

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*On a Self-acting Disengaging Hook.**

The frequency and fatal consequences of accidents arising from over winding or drawing the cage over the head gear pulley, have called the attention of colliery owners and inspectors to the means whereby such accidents may be avoided in future. The annexed engraving represents a self-acting spring hook, the invention of Mr. Robert Walker, of Eccleston, near Prescot, colliery viewer. This hook possesses all the qualities requisite to insure its general application in coal and other mines. When this hook is employed, it is impossible to wind the cage up sufficiently high to cause an accident. The mode of action is as follows:—When the cage is rising, the bridle, A, hangs in the hook, B, which is made with a spring catch, C. This catch closes the hook entirely, so that there is no possibility of the cage becoming disengaged in winding; but if, owing to the neglect of

* From the Lond. Practical Mechanic's Journal, August, 1860.

the engine driver, or from any other cause, the cage should be raised until the hook comes against the head gear pulley, D, as shown by the dotted lines, then the hook assumes a diagonal position, and the bridle, A, bearing upon the spring catch, C, causes it to open and to disengage the cage from the hook. When the cage is disengaged it is caught by retaining pawls or other apparatus, to prevent it descending the pit.

For the Journal of the Franklin Institute.

Binocular Vision, Theory of Images on Transparent Media, and the Stereomonoscope. By C. J. W., Jr.

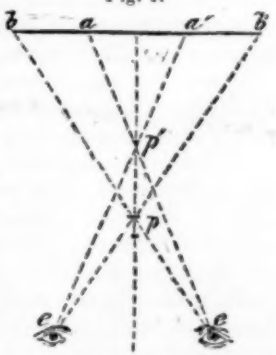
The laws of optics and of binocular vision are so well understood and have been so thoroughly investigated that any detailed recapitulation of them in this place would be supererogatory. It will, therefore, be necessary merely to allude to such as may have a direct bearing upon the subjects treated of in this article.

In viewing a landscape which possesses the advantage of a variety of planes of distance, first with both eyes simultaneously, and then with the right and left eye alternately, we shall perceive that in all these three instances, near and distant objects occupy different relative positions with regard to each other.

In the latter case, where the view is with either eye alternately, near objects will appear to have moved with regard to more distant ones, to the right when the right eye is closed and to the left when the left eye is closed.

Of course the reverse is the case when distant objects are viewed with regard to near ones. The amount of apparent motion will be in proportion to the relative direct distances of the observer from the objects viewed and of the objects from each other. In case, however, of vision with the eyes simultaneously, when the optic axes are directed to any point it will not appear in either of the positions to which it has been referred by the eyes separately, but will assume an intermediate one.

Fig. 1.



If *e e* (Fig. 1) represent the eyes, it will be seen that by closing them alternately, the near point *p* will have an apparent motion *b b'* when referred to that line; while the more distant point *p'* will only have an apparent motion *a a'* when referred to the same line; whereas if both eyes be turned to the points *p*, *p'* respectively, they will occupy an intermediate position between these two extremes.

When the optic axes are converged upon distant points, indistinct duplicate images of nearer points will be visible, separated in proportion to their proximity to the observer, and occupying the positions to the right and to the left respectively which they occupied when viewed

with either eye alternately, and *vice versa*, when the optic axes are directed to near points, distant ones are then duplicated and occupy the positions in which they were seen when viewed with the eyes successively. If the head is held out of the perpendicular so that a line joining the eyes shall not be a horizontal line, and the eyes fixed upon a distant point, the two images of a near point received by them will likewise be unequally elevated; that image being most depressed which is seen by the eye that is most elevated, and *vice versa*, that image most elevated which is seen by the eye that is most depressed.

All these phenomena are in perfect harmony with the law of visible direction, the integrity of which is preserved throughout. In the cases last alluded to, the elevated eye receiving the image by virtue of an ascending ray, and in obedience to this law, seeing it in a direction perpendicular to a plane tangent to the retina at the point of contact of this incident ray, receives the impression of a less elevated object. The other eye, however, perceiving the image by a ray less inclined, receives the impression of a more elevated object. The rays in both instances issuing from the same object, though entering the eyes with different degrees of inclination.

If we now, with a binocular camera properly constructed, having its lenses equally separated with the eyes of the observer, take photographic pictures of the objects before us and look at them with the assistance of the stereoscope, we shall be able to repeat all the experiments above suggested with the same results as when we were viewing the natural objects whose fac similes we are now in possession of.

These two dissimilar perspectives, taken at points two and a half inches distant, faithfully represent the right and left hand monocular views, and by alternately closing the right and left eye, near and distant objects will undergo changes in their relative position, precisely as they were seen to do in our natural vision of the landscape.

It is to the coincidence of these two dissimilar perspectives, effected by different degrees of convergency of the optic axes, that the stereoscopic illusion of solidity and relief is to be ascribed.

Allied to this in result, though effected through various ocular processes, are many other phenomena of vision, classified under the general title of optical illusions. Among the most noticeable of these is the relief produced by the copying of medals and other raised surfaces by the ruling machine.

This, like the one under discussion, is but another form of the projection of solids upon flat surfaces, the elevations and depressions of the medal corresponding with the different planes of distance of the stereoscopic object; and the effect of the deviation of parallel lines from their original parallelism in coming in contact with planes placed at all varieties of angles and of unequal elevations, in the one case, corresponding with the effect of the combination of dissimilar perspectives in the other.

This illusion of relief might also be in a measure produced, or at least enhanced, by calling into requisition the power of focal adjustment of the eye in connexion with the different degrees of refrangi-

bility of the prismatic colors. By giving objects intended to appear in relief that color whose ray is least refrangible, and those intended to recede from the eye, that color whose ray is most refrangible, we should invest them with at least one attribute of proximity and distance. In the former case the less refrangible ray would correspond in focal adjustment with the diverging rays of near objects, while in the latter case the more refrangible rays would correspond in focus with parallel rays of distant objects.

To this different degree of refrangibility of the prismatic rays may be ascribed the peculiarly unpleasant dazzling effect experienced in passing the eyes rapidly over certain combinations of colors. If the extremes of the solar spectrum representing the maximum and minimum of refrangibility be rapidly and consecutively presented to the eyes, each requiring a different focal adjustment to produce distinct vision, it can easily be conceived that the effect would be dazzling and confused.

In these latter instances the illusion would evidently be much more perfect if one eye alone were used; convergency now coming to our aid as a most powerful adjunct in dispelling an illusion, which, in the first case cited,—that of the stereoscope—it was exclusively instrumental in producing.

All these cases afford striking instances of the liability to error incurred by implicit reliance upon the evidence of any one witness, however perfect in itself; truth is only to be established by the concurrent testimony of all those with which nature has provided us for protection from deception and imposture, and for our better acquaintance with the works with which she has surrounded us.

We will now lay aside the photographic representations of the landscape, and with the aid of the stereoscope examine the images themselves as they appear depicted upon the ground glass of our binocular camera. In so doing a most unexpected and illusive effect will be produced.

All our previous knowledge of the distances of the various objects in view, is now completely at variance with the confused and illusive evidence of our senses.

We know, for example, that the sky is far more distant than the trees, and yet are small blue patches of it boldly protruding through apertures of the foliage and advancing into the foreground, while trees and their branches, known to be almost within our grasp, are modestly retiring and hiding themselves behind the distant skies. In fact, some potent spell appears suddenly to have inverted the entire order of things. Trunks of prominent trees seem to be sinking into, and almost enveloped by foliage that is behind them. Shadowy visions of leaves yielding to the breeze appear to pass behind the branches which they are actually placed in advance of, and which appear to have become magically endowed with transparency for the accommodation of the observer. In a word, the illusion is complete. All distant objects appear at hand, and all near objects far, in proportion to their proximity.

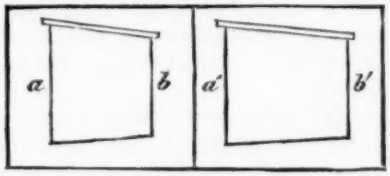
If Sir David Brewster's theory of the stereoscope required another

proof of its correctness, it would be found in this simple and interesting experiment; and it is a little singular that he makes no allusion to it in his work on that subject. In the case before us we find nearly all the elements essential to the formation of correct estimates of distance, such as magnitude, definition, perspective, &c., arrayed in direct antagonism to one solitary test, which is left to rebut their testimony single-handed and alone. It is that most essential element of vision, convergency, and although but one against many, it proves too strong for them all. For it is only by previous knowledge of the position of the objects of the landscape, or through some other means of information than the present modified form of vision affords, that we are enabled to dispel the illusion under which we labor, and be reassured of the actual order of nature.

A key to the mystery, however, is at hand. It will be found by analyzing the dissimilar perspectives projected upon the ground glass, that our lenses in inverting each picture separately have also inverted or rather reversed the relative horizontal separation of similar points of the various planes of distance upon which the stereoscopic effect depends.

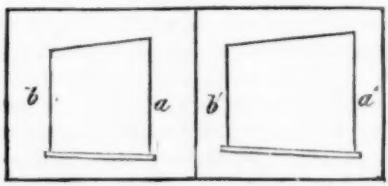
Similar points of near planes will now be found to be more distantly separated than similar points of distant planes. Whereas, in the erect pictures drawn from nature the reverse is the case, similar points of near planes being nearer than those of distant planes.

Fig. 2.



Suppose $a\,b$ and $a'\,b'$ (Fig. 2) to represent dissimilar perspectives of an object as seen by ordinary vision with the right and left eye alternately—$a\,a'$ represent similar points of near planes, while $b\,b'$ represent similar points of distant planes; $b\,b'$ being more distant from each other than $a\,a'$. Now suppose these two perspectives to be separately inverted as they are by the lenses of a binocular camera; their position will then be as in Fig. 3. It will there be seen that the lines b, b', which were in the first case more distant than a, a', now more nearly approach each other. Consequently upon application of the stereoscope to the first pair of dissimilar perspectives, points of near planes will be converged near to the eyes, and points of distant planes more distantly, following the course of natural vision, in which near points require a greater degree of convergency than distant ones.

Fig. 3.



With the latter pictures, however, the reverse is the case. For similar points of near planes being more separated will be converged at a greater distance than similar points of distant planes. Thus reversing the order of nature and producing that confusion and inversion of distances already described.

These perspectives reversed as they now appear on the ground glass of the camera, are in a proper position to produce a correct impression combined ocularly without the intervention of the stereoscope, provided the image is formed before and not beyond the ground glass; for in that case the greater the separation of corresponding points of perspective, the more nearly to the observer will the points of their coincidence be approached. The image that results from this combination will be diminished in size in proportion as it approaches the eye. Our estimate of its dimensions being formed by the conviction that convergency affords of its increased proximity, together with the impression on the retina, which shows that it subtends the same visual angle, the deduction is, that what is nearer, and yet subtends no greater angle, must be smaller. In viewing these pictures with the stereoscope the effect is quite different, for then convergency is effected at almost the same distance from the eye of the observer as the pictures themselves are placed; there is nothing, therefore, to indicate diminished distance, and consequently no impression of decreased dimensions in the resultant image.

It is owing to this inversion of perspectives that we are obliged to divide the stereoscopic photographs taken by a binocular camera, and reverse their position, in order to produce a proper effect when placed in the stereoscope, and not as has been stated, because we have reversed the pictures in placing the undivided images erect. This certainly puts the right hand picture on the left hand side, but in no degree disturbs the relative distances of similar points, upon which the result wholly depends.

It is an easy problem to place the images in an erect position in the camera, by first receiving them upon a mirror and reflecting them thence upon the ground glass. But this process, although it places the images erect, or rather enables us to view them ourselves in an inverted position, effects no change in the perspectives, and consequently upon application of the stereoscope the illusion of distances remains unchanged.

If, however, we wish to witness the effect of reversing the perspectives in reality at the same time that we place the images in their natural erect position, we have only to place behind each of the object glasses of our camera another lens at a distance greater than the sum of the principal foci of both, (*i.e.* the object and the auxiliary lens,) and permit the landscape to be refracted by both of these lenses upon the ground glass. This arrangement will, of course, have the effect of separately reinverting the images, and will place them in their natural position upon the ground glass, their perspectives perfect, and upon application of the stereoscope we shall perceive a living picture of the landscape before us.

We now come to the beautiful and ingenious discovery of Mr. Claudet.

The writer in adjusting the focus of objects on the ground glass of the camera obscura, had often been struck with the impossibility of obtaining a satisfactory view of the image except from certain angles of observation, and was, therefore, particularly pleased with Mr. Claudet's investigations in elucidation of the mystery.

Mr. Claudet's discovery was announced to the Royal Society in June, 1857, and a notice of it subsequently, July, 1858, copied into this Journal. The author says, "that having observed that the image on the ground glass of the camera obscura appeared as much in relief as the natural objects themselves when seen with two eyes; that his experiments and researches as to the cause, have disclosed the singular fact that though only one image seems depicted thereon, two really exist, one visible only to the right eye and the other only to the left. That the image seen by the former is refracted by the left side of the lens, and that seen by the latter by the right side of the lens. Consequently that these two images presenting two different perspectives, the result is the same as when two different perspectives are viewed with the stereoscope. That all the different images refracted by every part of the lens are each only visible on the line of their refraction when it corresponds with the optic axes."

Mr. Claudet further remarks that if the image be received upon transparent paper instead of ground glass, the illusion of relief is not in the least presented, that all the images refracted from all parts of the lens coincide upon the paper and are visible at whatever angle they are examined. The reason of this difference being that the rays refracted by the lens continue their course in straight lines through the transparent molecules of the ground glass, and are seen only when they coincide with the optic axes; while the paper being perfectly opaque stops all the rays, and becoming itself luminous sends new rays in all directions.

In elucidation of this new principle of ground glass images, Mr. Claudet proposes a number of experiments made with different colored glasses placed before marginal openings of the lens, &c.; and having convinced himself of its correctness, suggests the possibility of a stereoscope being constructed upon this new principle, in which the eyes looking upon a single image could see it in perfect relief. This single image being composed of two images superposed, one visible only to the right eye and the other only to the left.

In a subsequent paper read before the Royal Society in April, 1858, Mr. Claudet states, "that he had succeeded in constructing a stereoscope upon this new principle, to which he had given the name of stereomonoscope, in allusion to its power of producing the stereoscopic effect with apparently but one image."

In pursuance of this interesting subject, the writer has repeated the experiments suggested by Mr. Claudet, some with perfect, all with partial success.

It is not strictly true that, "when looking at the image on the ground glass of a camera obscura, the right eye sees only that refracted by the left side of the lens, and the left eye only that refracted by the right side;" for when the entire lens is exposed, the rays passing through its centre are so slightly converged that each eye receives a portion from both sides of it. The perspectives are thus mingled and the stereoscopic effect greatly impaired.

This is particularly observable when the rays entering the right and

left sides of the lens are passed through different colored glasses. A mingling of colors in the centre will be perceptible to either eye to nearly the same extent as when both are used simultaneously.

In conducting these experiments, therefore, it is desirable to exclude the central rays. This is most effectually accomplished by covering the entire face of the lens, and then making marginal apertures at the extremities of its transverse axis. If the lens used has a diameter of four or five inches with marginal apertures of not more than one or one and a half inches, into which are introduced tubes about six inches long, so as to exclude all rays which will not reach the ground glass but may fall upon other parts of the camera—it will then be in a condition to produce the most striking effect.

The contraction of the marginal apertures not only enhances the effect by the exclusion of unnecessary light, but likewise diminishes spherical aberration by reducing the surface of the lens exposed, and proportionally improves the definition of the image; while the inequality of focal distance of differently distant objects and consequent varying convergency of the refracted rays remains unimpaired. The divergency of rays incident upon the lens being by this arrangement at a maximum.

The result is quite different when rays are admitted through an equal aperture in the centre of the lens; for then all rays from near as well as distant points enter it with nearly the same degree of parallelism, and are consequently refracted to points at nearly the same distance behind the lens, and with nearly the same degree of convergency.

If, with the camera arranged as above described, a piece of blue glass be placed before the right hand aperture of the lens, and a piece of yellow glass before the left, the eyes placed equally distant from the centre of the ground glass, will perceive thereon a union or mingling of both these colors. When viewed, however, with the right and left eye alternately within a certain radius, the yellow ray will alone be perceptible to the right eye and the blue ray only to the left.

If the colored glasses be now removed and the camera turned to the landscape, an effect of relief almost magical will be presented. Supposing the camera to be adjusted to the focus of the nearest visible objects; then, by fixing the eyes steadily upon their images and gradually moving the ground glass in towards the lens until middle and greater distances become distinctly delineated, these images of near objects upon which the eyes are fixed, instead of receding with the ground glass, will remain in their original places, *i.e.* at their respective points of convergency, until they appear to stand out several inches in advance of the rest of the picture; while images of more distant objects not perfectly in focus on the ground glass will appear to be placed equally distant behind it. Upon observing one of these boldly advanced images with both eyes placed directly opposite to it, and then by alternately closing them, it will be seen that this image has a lateral motion with regard to other objects depicted on the ground glass, just as was observed in viewing the objects themselves by ordinary vision or their photographic representatives with the stereoscope. If the left

eye be closed and the head moved slowly in that direction, a faint duplicate image will become visible to the right of the one in question, growing gradually brighter as the motion is continued, the place of which the original image immediately assumes when the right eye is closed and the left opened, but one image again being visible.

With the right eye closed and the head moved to the right, a left hand duplicate image becomes visible, the place of which the right hand one assumes upon again reversing the eyes.

In both these cases, the distinct image is seen by virtue of rays admitted through the opposite aperture to the eye that receives them, and with the axis of which they are brought to coincide. The faint image being the result of rays passing through the other aperture, not distinctly seen until the axis of this eye is in turn brought to coincide with them. The binocular image in front of the ground glass is seen at the point of convergency to which these two images are approaching.

These striking effects, which we have with so much pleasure observed, will entirely vanish by changing the marginal apertures of our camera from a horizontal to a vertical position. By this arrangement we have reduced our lens to an equivalent with a central aperture equal in diameter with the marginal ones; and although objects are seen by rays transmitted through precisely the same apertures as before, we have exchanged lateral for vertical convergency, and this latter does not avail us in the estimation of distances, producing no corresponding convergency of the optic axes.

If, with the apertures restored to their original horizontal position, transparent paper be substituted for ground glass for the reception of the image, the effect will be modified inversely to the degree of transparency to which the paper is reduced, but not, as Mr. Claudet asserts, entirely destroyed.

The mingling of perspectives will be much more conspicuous, each having a greatly increased range of visibility, so that much greater deviation from the line of refraction is requisite to render the images of either aperture invisible. For the same reason, the paper presenting so much greater obstruction to the transmission of the rays of light—no image is visible at the point of convergency of these rays if at all distant from its surface. No other principle appears to exist in transparent paper effecting this result—as Mr. Claudet insinuates when he says that "paper (*i.e.* transparent paper) being perfectly opaque stops all rays on their passage, by which the image remains fixed on its surface"—except the degree of its transparency. Transparency being that property of a medium which presents no obstruction to the rays of light, and which permits rays refracted on its surface to be seen only in the direct line of their refraction, producing no illumination of the surface at the point of contact visible in other directions; partial transparency, however, admits of partial transmission of the rays of light, rendering objects refracted upon a medium possessing it visible not only in the direct line of refraction but in other directions, in inverse ratio to the degree of its transparency, the surface becoming luminous at the point of contact of the incident ray.

To this latter class belong ground glass, transparent paper, so called, &c.

In confirmation of the similarity of these two media with regard to the transmission of light, notwithstanding Mr. Claudet's assertions to the contrary, the writer has observed that when a double thickness of ground glass or a piece coarsely ground is used, the effects peculiar to transparent media are impaired to almost the same extent as when prepared paper is substituted. On the contrary, when prepared paper is used as a medium, all these effects will be preserved in proportion to the degree of its transparency. This should evidently not be the case if "ground glass were perfectly transparent," or if "paper were wholly opaque."

All these experiments tend to establish the possibility of rays of light rendering themselves visible in other directions than the line of refraction when received upon a ground glass; and if further proof were required it would be found in the improved field of the camera when constructed with a combination of lenses, obtained by the introduction of a second ground glass at the focus of the anterior lens. This conclusively proves that more rays now reach the original ground glass in formation of the ultimate image, than reached it before the introduction of the second ground glass, and consequently that the image of the anterior lens is seen through the instrumentality of this second ground glass in other directions than the direct line of refraction of the rays that form it.

The success of these experiments, therefore, greatly depends upon the degree of transparency of the medium used for the reception of the image; and after procuring the finest ground glass for the purpose, the writer has found the best effect produced by slightly oiling its ground surface, a much greater degree of transparency being thus acquired. Under these circumstances the mingling of perspectives is at a minimum, and the least resistance offered to the projected ray. Every object is seen at its proper focal point instead of on the surface of the ground glass, the rays either before or after convergency passing through it unobstructed. Those objects only are now visible on the ground glass which properly belong there, together with the most distant objects of the landscape, whose ray is too feeble to make its way through in a clearly defined image visible at its point of convergency.

Mr. Claudet is not definite as to the manner in which this convergency is produced; whether mechanically by coincidence of similar points of dissimilar perspectives, as in the stereoscope, or naturally by consecutive concentration of the optic axes upon the various points of the image. In the case under consideration, it is evidently in a degree mechanical, inasmuch as it is instituted by the refractive power of the lens exercised upon the rays issuing from the several points of the object and crossing at their focal point, effecting a corresponding degree of convergency of the optic axes when coincident with them. The image nevertheless is seen as in natural vision without the intervention of further mechanical agency.

The writer having passed through these initiatory steps, has further benefited by the suggestions of Mr. Claudet, and constructed the instrument to which the inventor has given the name of Stereomonoscope.

This instrument much resembles both in construction and appearance an elongated camera obscura, the object to be represented on the ground glass being a stereoscopic plate. The lens of the camera is divided into two semi-lenses, one of which has a rotary as well as lateral motion, in order that the images of the plate may be perfectly superposed.

When properly adjusted the resultant image on the ground glass will be seen in perfect stereoscopic relief.

The success of this instrument is entirely dependent upon the principles investigated in the foregoing article.

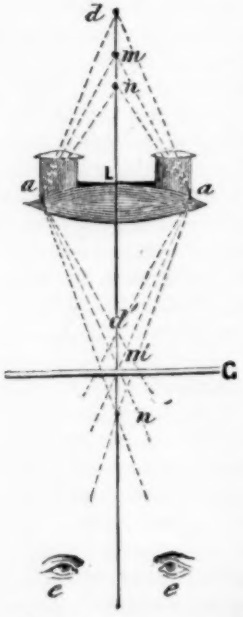
Mr. Claudet naturally supposed that if by refraction of the lens of a camera obscura, two images of an object were so combined upon the ground glass as to produce the stereoscopic illusion, so two separate perspectives of an object might, by the same means, be combined and result in producing a similar effect.

Experiment verified the sagacity of the inference.

The construction and operation of the camera used in the foregoing experiments as well as of the instrument now under consideration, may be better understood by reference to the figures below.

Let *n m d* (Fig. 4) represent near, middle, and distant points of a landscape, and suppose rays issuing from these three points to pass through the marginal apertures *a a* of the lens L of a camera obscura, the remainder of the lens being covered. And let the ground glass G be so adjusted that rays from the middle distance *m* be refracted to a focus precisely upon its surface. It is evident that the more divergent rays from the near point *n* will be more distantly converged at a point *n'* in advance of the ground glass G; while the less divergent rays from the distant point *d* will be converged at a point *d'* behind the ground glass; that these rays, all possessed of different degrees of convergency, will pursue their course, and meeting the eyes at *e e*, will effect a corresponding degree of convergency of the optic axes when coincident with them. The points *n m d* will thus be represented in relief at *n' m' d'* respectively.

Fig. 4.

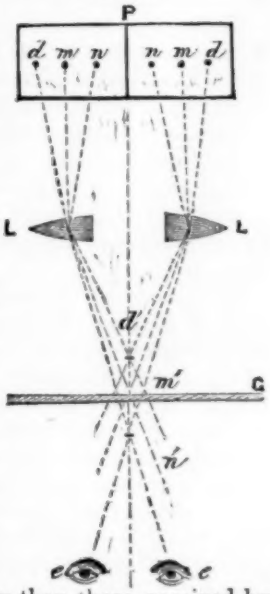


Now, let *n m d*, *n m d* (Fig. 5) represent projections of dissimilar perspectives of these same points upon the surface of the stereoscopic plate P.

Let L L represent semi-lenses so separated that rays from the points of middle distance *m m* shall be precisely superposed on the ground

glass G placed at the focus of the semi-lenses. It is evident that rays from the points *n n*, representing a near point of the landscape and consequently more nearly approached in the perspectives, will fall upon the lenses L L with a greater degree of divergency, and will, consequently, be converged at a more distant point *n'* in advance of the ground glass; while rays from *d d* representing a distant point of the landscape and already possessed of a degree of convergency will be converged at a near point *d'* behind the ground glass; and that all these rays possessed of different degrees of convergency will, as in the previous case, by instituting a corresponding degree of convergency of the optic axes, be seen in relief at the points *n' m' d'* respectively.

Fig. 5.



It may be objected that in these figures rays issuing from the distant points *d* are after refraction, possessed of a greater degree of convergency than those issuing from near points *n*. This, however, is only an imperfection in the diagrams, submitted to in order to avoid confusion with lines crossing one another. It is evident that the rays converged at *d'* as seen in the figures could never reach the eyes as there placed, and that rays converged at that point could meet them only when transmitted through a more central part of the lenses; and further, that the principle upon which the figures are constructed insures by the eyes the reception of no rays from distant points possessed of a greater degree of convergency than those received by them from near points.

In enumerating the advantages of the stereomonoscope over the ordinary lenticular stereoscope, it is suggested that a considerably enlarged image may be thrown upon the ground glass, and that this may be subsequently still further increased by viewing it with a large convex lens.

It is undoubtedly true that the stereoscopic image may be somewhat magnified by the semi-lenses by which it is formed, but certainly not without limit.

It must be remembered that we cannot magnify the images of which it is composed without at the same time magnifying their differences of perspective, and this by increasing the distance between their respective points of convergency, renders that process much more difficult for the eyes to effect. Yet another consequence of this amplification would be to create an appreciable difference between the point of superposition of any two similar points of the perspectives and the focal point of the rays issuing from said points, thus interfering with the distinctness of the resultant image. Add to these objections the

diffusion of light entailed by the process and its consequent enfeebled transmission through the ground glass, and it will readily be understood that there is a most decided barrier to this species of improvement.

With regard to subsequent magnifying of the image by means of convex lenses, a difficulty will also be found; for in this way we likewise exaggerate the coarseness of the surface upon which it is projected. It must, therefore, be admitted that no very great advantages are to be anticipated from amplification.

Neither, as has been insinuated, can the image be satisfactorily seen from a variety of points of view, for in passing the eyes over it slowly it will be observed that instantly as the converging ray from any point is lost to either eye, will that point of the picture lose its relief and recede to the surface of the ground glass.

In convenience and portability likewise does this instrument in no degree approach its rival the stereoscope.

The very exigences of the principle to be developed are antagonistic to the exercise of any great degree of economy of space in its construction.

That made by the writer is furnished with semi-lenses seven inches in focal length. To produce an image equally large with the object, it is necessary that the latter be placed double the focal length in front of the lenses; the image will then be formed an equal distance behind them. We have thus an instrument twenty-eight inches in length, which must further be carefully inclosed so as to exclude all light not directly instrumental in the formation of the image.

We therefore see that in point of convenience or in perfection of result, the stereomonoscope possesses no advantages over the lenticular stereoscope, and is not likely "to produce a revolution in the application of that splendid discovery to the exhibition of photographic pictures."

This, however, in no degree detracts from the credit due its inventor, for as an instrument illustrative of a new principle in optics and suggestive of solutions to many hitherto unrecorded, if not entirely unobserved phenomena, it is worthy of all admiration and its inventor deserving of all praise.

Germantown, October 7th, 1860.

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*The Reaping Machine known to our Celtic Forefathers.**

Truly, there is "nothing new under the sun." A correspondent of the *Gloucester Chronicle* thus writes as to reaping machines:—"It may, perhaps, be interesting to you and to your readers to learn that those 'utter barbarians,' as our British ancestors have been wont to be called, were before us in many of the inventions which are supposed to be the result of modern ingenuity. I am not prepared to say that they had the steam plough, but that they had reaping machines there can be no doubt in the minds of those who read the fol-

*From the London Engineer, No. 241.

lowing much-overlooked passage of Pliny, who wrote between the years 60 and 70 of the Christian era:—

De Messe et Tritico.

Messis ipsius ratio varia, Galliarum latifundiis, valli prægrandes dentibus in margine infestis duabus rotis per segetem impelluntur, jumento in contrario juncto, ita direptæ in vallum cadunt spiciæ.

Of reaping itself there are various methods; in the broad plains of the Gauls, enormous machines with teeth set in a row, placed on two wheels, are driven through the standing corn, a horse being attached to it in a contrary way to the usual mode of attaching horses. Thus the corn, being cut off, falls into the furrow.—*Pliny's Natural History, Book* 18, *chap.* 30.

Some question may arise whether we should translate *vallum* as it occurs in the latter part of this sentence differently from the sense given that word at the beginning, *vallus* being a van or machine (see Ainsworth's Dictionary), and *vallum* being a trench or furrow. If we adopt the latter translation, then it follows that our ancestors had already attained that excellence in their machine which was with such difficulty effected in those of modern construction. If, on the other hand, we translate it as the machine itself, then they had accomplished that which our modern inventors have not yet succeeded in, for they must have made the machine not only to reap, but to carry away the corn."

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By Chas. H. Haswell, Civil and Marine Engineer.

No. 1.

Elasticity and Strength.

The component parts of a rigid body adhere to each other with a force which is termed *Cohesion.*

Elasticity is the resistance which a body opposes to a change of form.

Strength is the resistance which a body opposes to a permanent separation of its parts.

Elasticity and *Strength*, according to the manner in which a force is exerted upon a body, are distinguished as

1st.—*Tensile Strength*, or Absolute resistance.
2d. —*Transverse Strength*, or resistance to Flexure.
3d. —*Crushing Strength*, or resistance to Compression.
4th.—*Torsional Strength*, or resistance to Torsion.
5th.—*Detrusive Strength*, or resistance to Shearing.

Modulus of Elasticity.

The *Modulus* or *Co-efficient of the Elasticity* of any substance, is a column of the same substance, capable of producing a pressure on its base, which is to the weight causing a certain degree of compression, as the length of the substance is to the diminution of its length; or it is the measure of the elastic reaction or force of any substance.

To ascertain the Extension or Compression in the Length or Height of a Body.

$\text{Q}\, l = \text{E}$. Q *representing the quantity a prism of any substance one inch square and a foot in length, would be extended or diminished by a force or weight f; and l any other length of a prism of like section and substance.*

To ascertain the Modulus of Elasticity.

RULE.—As the extension or compression of the length of any substance is to its length, so is the weight that produced that extension or compression to the result required.

Or, $\frac{f}{\text{Q}} = \text{M}$; M *representing the weight of the modulus in pounds, for a section or base one inch square.*

If W is the weight of the prism of one inch square and one foot in length,

Then $\frac{f}{\text{W Q}} = \text{H}$; H *representing the height of the modulus of elasticity in feet.*

To ascertain the weight which a given column, nearly perpendicular, is capable of supporting, omitting the effect of the weight of the column itself:

$\cdot 8225\ \frac{d^2}{l^2}\,\text{H} = \text{W}$; *d representing the side of the column.*

Illustration.—A column of pine, assuming the height of its modulus to be 9,000,000 feet, one inch square, and 5 feet in length, may begin to bend with the weight of a like column, equal in length to

$$\cdot 8225 \times \frac{1^2}{(5 \times 12)^2} \times 9{,}000{,}000 = 2056 \textit{ feet},$$

or, with a weight of $(2056 \times \cdot 02 \times 12$, *the product of the length and the weight of* 12 *inches*) 493·44 lbs., *omitting the weight of the column itself.*

The Weight of the Modulus of Elasticity of a horizontal bar fixed at one end, is to a weight suspended from its extremity, as four times the cube of the length, to the product of the square of the depth and the depression.

The Height of the Modulus of Elasticity of a bar, supported at both ends, is ·156 of the fourth power of its length, divided by the product of the depression and the square of the depth.

The weight under which a vertical column or bar not fixed at its base may begin to bend, is to a weight laid on the middle of the same bar, when supported at its ends in a horizontal position, nearly in the ratio of ·002 of the length to the depression.

Modulus of Height of Elasticity of various substances, and the portion of it, which, if applied lengthwise to them, would pull them asunder.

Substances.	Feet.	Height of the prism which would be severed by its own weight.	Proportion of height of cohesion to elasticity.
Ash,	4,617,000	42,080	109 th
Beech,	4,180,000	38,940	107
Brass,—Yellow	4,940,000	5,180	954
Brick,		970 144	
Cane,	1,400,000		
Cork,	3,300		
Copper,—Cast		5,000	
Deal,	8,118,000	55,500	146
Elm,	5,680,000	39,050	146
Fir,	8,292,000	40,500	205
Glass,	4,440,000		
Gun Metal,	2,790,000		
Hempen Fibres,	5,000,000		
" Twine,		75,000	
Iron,—Cast	5,750,000	6,110	941
" Wrought, Swedish,	9,000,000	19,740	456
" " English,	7,550,000	16,938	446
Ice,	6,000,000	300	20,000
Limestone,	2,400,000		
"	1,600,000		
"	625,000		
Lignum Vitæ,	1,850,000		
Larch,	5,096,000	42,160	121
Lance Wood,	5,100,000		
Lead,—Cast		348	
Mahogany,	7,500,000		
Marble,—White	2,150,000	1,542	1394
Oak,	4,150,000	32,900	144
Rosewood,	3,600,000		
Slate,	7,800,000	7,300	1068
Steel,—Cast	9,300,000	39,455	235
Stone,—Portland	1,570,000	945	1789
Tanned Cow's Skin,		10,250	
Teak,	6,040,000	36,049	168
Tin,—Cast		1,496	
Whalebone,	1,000,000	14,000	71
Willow,	6,200,000		
Writing Paper,		8,000	
Yellow Pine,	9,150,000		
"	11,840,000		

Modulus of Weight of Elasticity of various substances.

Substances.	Weight in lbs.	Substances.	Weight in lbs.
Ash,	1,525,000		
Oak,	1,713,600	Cast Iron,	13,000,000 to 17,000,000
Oak,—American	1,958,700		
Yellow Pine,	1,856,400	Steel Wire,	29,500,000
Pitch Pine,	1,252,000	Steel Plates,	42,600,000
Red Pine,	2,142,000	Spruce,	1,244,000
Bar Iron,	28,400,000	Zinc,	13,680,000
Wire,	28,081,000	Brass,	8,930,000
Beech,	1,316,000	Lead,	720,000
Mahogany,—Spanish	1,255,000	Gun Metal,	9,873,000

Tensile Strength.

Tensile Strength is the resistance of the fibres or particles of a body to separation. It is therefore proportional to the number of fibres or particles in the body, or to the area of its transverse section.

The *Absolute Strength* of materials, pulled lengthwise, is in proportion to the squares of their diameters.

Table of the Tensile Strength of Materials.

Power required to tear asunder one Square Inch, in Avoirdupois pounds.

Metals.	lbs.		lbs.
Copper, Wrought	34,000	Iron, Plates, boiler	51,000
Cast, American	24,250	" lengthwise	53,800
Wire	61,200	" crosswise	48,800
Bolt	36,800	" ship	44,000
Gold, Cast	20,000	" lengthwise	47,600
Iron, Cast, Low Moor	14,076	" crosswise	40,600
Clyde, No. 1	16,125	Inferior bar	30,000
" 3	23,468	Lead, Cast	1,800
Calder, No. 1	13,735	Milled	3,320
Stirling, mean	25,764	Wire	2,580
Mean of American, by Major Wade,	31,829	Platinum, Wire	53,000
Greenwood, American	45,970	Silver, Cast	40,000
Gun metal, mean	30,232	Steel, Cast, maximum	142,000
Wire	103,000	Blistered soft	133,000 to 104,000
Best bar, Swedish	72,000	Shear	118,000
Russian bar	59,500	Blister	104,000
English bar	56,000	Spring	72,500
Rivets, American	53,300	Puddled	67,200
Mean by Telford	65,520	Plates, lengthwise	96,300
" Brunel	68,992	" crosswise	73,700
" Barlow	56,560	Razor	150,000
English rivets	65,000	Tin, Cast block	5,000
Crank shaft	44,750	Banca	2,122
Turnings	55,800	Zinc, Cast	3,500
Scrap	53,400	Sheet	16,000

Woods.

	lbs.		lbs.
Ash,	12,000 to 16,000	Oak, American white	11,500
Beech,	11,500	English	10,000
Box,	20,000	Seasoned	13,600
Bay,	14,000	Riga	12,000
Cedar,	11,400	African	14,500
Chestnut, Sweet	10,500	Pine, Pitch (Fir),	12,000
Cypress,	6,000	Norway	13,000
Deal, Christiana	12,400	American White	11,800
Elm,	13,400	Poplar,	7,000
Lance Wood,	23,000	Quince,	6,000
Lignum Vitæ,	11,800	Sycamore,	13,000
Locust,	20,500	Teak, Java	14,000
Mahogany,	21,000	African	17,000
Spanish	12,000	Walnut,	7,800
Maple,	10,500	Willow,	13,000

Compositions.

	lbs.		lbs.
Gold 5, Copper 1,	50,000	Copper 8, Tin 1, small bars,	50,000
Brass,	42,000	Yellow metal,	48,000
" Yellow	18,000	Silver 5, Copper 1,	48,000
Bronze, least	17,698	" 4, Tin 1,	41,000
" greatest	56,788	Tin 10, Antimony 1,	11,000
Copper 10, Tin 1,	32,000	" 10, Zinc 1,	12,914
" 9, " 1,	17,250	" 10, Lead 1,	6,800
" 8, " 1, gun metal,	30,000		

Miscellaneous Substances.

	lbs.		lbs.
Brick, well burned	750	Rope, Manilla	3200
inferior	290	Wire	37,000
Chalk,	118	Hemp	6400
Cement, Portland, 6 mos.	414	Mortar, 20 years,	52
" " 7 "	400	Plaster of Paris,	72
Glass, Plate	9400	Slate,	12,000
Flint	4200	Sandstone, Fine grain	200
Green	4800	Stone, Portland	857 to 1000
Crown	6000	Hailes	360
Hemp Fibres,	6400	Craigleith	400
glued together,	9200	Bath,	352
twisted, ¼ to 1 in. dia.	8746	Cement, Sheppy	24
1 to 3 "	6800	Harwich	30
3 to 5 "	5345	Chalk 4, Blue clay 5	70
5 to 7 "	4860	Portland 1, Sand 3	380
Ivory,	16,000	Whalebone,	7600
Marble, White	9000		
Italian	5200		

Hemp ropes, 1 ton per lb. weight, per fathom.
Wire ropes, 2 tons per lb. weight, per fathom.

Cast iron (Greenwood) at three successive meltings, gave tenacities of 21,300, 30,100, and 35,700 lbs.

Bronze (gun metal) varies in tenacity from 23,000 to 54,500 lbs.

The fibres of woods are strongest near the centre of the trunk or limb of the tree.

Experiments on cast iron bars give a tensile strength of from 4000 lbs. to 5000 lbs. per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended one five thousand five hundredth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended less than the three thousandth part of its length.

The mean tensile strength, then, of cast iron being from 16,000lbs. to 20,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from one-fourth to one-third of this, or of its breaking strain.

A bar of cast iron will contract or expand ·000006173, or the 162,000ths of its length for each degree of heat; and assuming the extreme range of the temperature in this country, between the shade in winter and the sun's rays in summer, in the Middle States, to be 140° (—20° + 120°), it will contract or expand with this change ·0008542, or the 1157ths of its length.

It follows, then, that as 2240 lbs. will extend a bar the 5500th part of its length, the contraction or extension for the 1157th part, will be equivalent to a force of 10,645ths (4·75 tons) per square inch of section.

Experiments on wrought iron bars give a tensile strength of from 18,000 lbs. to 22,400 lbs. (10 tons) per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended the ten-thousandth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended the one-thousandth part of its length.

The mean tensile strength, then, of wrought iron being from 55,000 lbs. to 65,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from three-tenths to one-fourth of this, or of its breaking strain.

A bar of wrought iron will expand or contract ·000006614, or the 151,200th part of its length for each degree of heat; and assuming, as before stated for cast iron, that the extreme range of temperature in the air in this country is 140°, it will contract or expand with this change, with a force equivalent to 20,740 lbs. (9·25 tons) per square inch of section.

The tensile force of metals varies with their temperature, generally decreasing as the temperature is increased.

In silver, the tenacity decreases more rapidly than the temperature; in copper, gold, platinum, and palladium, it decreases less rapidly than the temperature.

In iron, the tenacity is less at 212° than at 32°, and at 392° it is greater than at 32°.

Tensile strength of the strongest piece of cast iron ever tested,—45,970 lbs. This was a mixture of grades 1, 2 and 3 of Greenwood iron, and at the 3d fusion.

Adhesion of Roman cement to blue stone, 77 lbs. per square inch.

Table of Elements connected with the Tensile Resistance of various substances.

Substances.	Tensile Strain per square inch for limit of elasticity.	Proportional elongation for strain of limit of elasticity.	Ratio of strain in column 1 to that causing rupture.
	lbs.		
Oak,	2,856	·00167	·23
Yellow Pine,	3,332	·00117	·33
Beech,	3,355	·00242	·30
Wrought Iron, ordinary	17,600	·00062	·30
Swedish	24,400	·00093	·44
English	18,850	·00072	·37
	22,400	·00086	·44
American	21,000	·00080	·40
do. Wire, No. 9, unannealed	47,532	·00165	·49
annealed	36,300	·00129	·58
Steel Plates, blue tempered	93,720	·00222	·67
Wire,	35,700	·00120	·50
Cast Iron, English	4,000	·00116	·25
American	5,000	·00149	·25

(To be Continued.)

For the Journal of the Franklin Institute.

Particulars of the Steam Ferry Boat John P. Jackson.

Hull built by O. Burtis, Brooklyn, N. Y. Machinery by William Birkbeck, Jersey City, N. J. Owners, New Jersey Transportation Company.

Hull.—Length on deck, 210 ft. Do. at load line, 210 ft. Breadth of beam (molded), 33 ft. Depth of hold, 13 feet. Do., to spar deck, 13 feet. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 12 ins. Keel, depth, 11. Draft of water, forward and aft, 5 feet 6 inches. Tonnage, 858. Area of immersed section at load draft of 5 feet, 140 sq. feet.

Engines.—Vertical beam. Diameter of cylinder, 45 ins. Length of stroke, 11 feet. Cut-off at one-third.

Boiler.—One—Drop flue, round shell. Length of boiler, 30 feet. Breadth of do., 10 feet. Height do., exclusive of steam chimney, 10 feet. Number of furnaces, two. Length of grate bars, 6 ft. Number of flues, above, 6 of 15½ ins.; in centre, 6 of 15 ins.; below, 2 of 23 ins., 2 of 14 ins. Length of flues, above, 18 ft.; in centre, 15 ft. 10 ins.; below, 17 ft. 10 ins. Diameter of smoke pipe, 4 ft. 6 ins. Height do., 48 ft.

PADDLE WHEELS.—Diameter over boards, 21 feet. Length of blades, 9 feet. Depth do., two of 12 ins. Number do., 18.

Remarks.—This is the largest ferry boat ever built in this section of the country, and is to ply between the City of New York and Jersey City. Date of trial, October, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer John P. King.

Hull built by J. A. Westervelt & Sons. Machinery by Allaire Works, New York. Owners, Spofford, Tileston & Co.

HULL.—Length on deck, 235 ft. Do. at load line, 233 ft. Breadth of beam (molded), 36 ft. 4 ins. Depth of hold, 13 ft. 3 ins. Do., to spar deck, 20 feet. 9 ins. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins. Keel, depth 11. Draft of water, forward and aft, 12 ft. Tonnage, 1740. Area of immersed section at load draft of 12 ft., 371 sq. ft. Masts, two.—Rig, schooner.

ENGINES.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke, 12 feet. Maximum pressure of steam, 30 lbs. Cut-off—variable.

BOILERS.—Two—Return flue. Length of boilers, 26 ft. Breadth of do., 12 ft. 2 ins. Height do., exclusive of steam chimney, 12 ft. 2 ins. Number of furnaces, 5 in each. Breadth do., 3 ft. ½ in. Length of grate bars, 7 ft. 3 ins. Number of flues, above, 18, below, 15. Internal diameter of flues, above, 8 of 13 ins., 8 of 11 ins., 2 of 10 ins.; below, 15 inches. Length of flues, above, 19 ft. 4 ins., below, 12 ft. 7 ins. Grate surface, 225 sq. ft. Heating surface, 5426 sq. feet. Diameter of smoke pipes, 7 feet. Height of do., 60 feet.

PADDLE WHEELS.—Diameter over boards, 28 feet. Length of blades, 10 feet. Depth do., 12 ins. Number do., 24.

Date of trial, October, 1860. C. H. H.

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*Description of Fryer's Apparatus for Filling Locomotive Tenders with Water.** By Mr. JAMES FENTON, of Low Moor.

Dr. Papin, the celebrated French precursor of the many inventions connected with modern steam power, demonstrated, as early as the year 1700, the practicability of raising water by the direct action of steam pressure on its surface; and this system is still adopted with complete success for raising saccharine fluids in most sugar houses throughout the world. The method of filling locomotive tenders with water, where the supply is below the level of the railway, recently invented by Mr. Alfred Fryer, of Manchester, and forming the subject of the present paper, is, in fact, an adaptation of Dr. Papin's simple contrivance of 160 years ago.

The apparatus consists of a wrought iron cylinder of 1500 or 2000 gallons capacity, placed upright beneath the surface of the supply water, which may be from 10 to 120 feet below the level of the rail-

* From Newton's London Journal, August, 1860.

way. To reduce the amount of condensation, the cylinder is surrounded with brickwork, and a space of 2 inches between the brickwork and the cylinder is filled with clay, to prevent any water from getting to the outside of the cylinder. The cylinder contains a wrought iron float, fitting it easily, and sliding on a centre guide-rod. The supply water enters through a self-acting inlet valve, of about 75 square inches area, at the top of the cylinder, and it is discharged from the bottom of the cylinder through a pipe leading to the engine water-crane. A steam-pipe is attached to the top of the cylinder, leading to two pillars placed a few yards distant on each side of the crane, and near the line of rails, and provided with flexible pipes, having bayonet joints for coupling to the locomotive boiler. When a tender is drawn up to be filled, the engine-driver couples one of the flexible pipes to the boiler, and turns on the steam, which, passing into the water cylinder, presses on the float, and forces the water up through the crane into the tender with great rapidity.

To prevent the steam now contained in the upper part of the cylinder from blowing out violently into the atmosphere when the flexible pipe is disconnected, a valve is placed in the top of the pillars, opening inwards, which allows a free passage for the steam to enter the cylinder; but when the pipe is uncoupled, the steam can only escape slowly through a small hole drilled in the valve. A hanging valve is placed between the two branches of the steam-pipe, which prevents the steam entering through one of the pillars, from blowing out direct through the other, instead of passing down into the cylinder. As the steam escapes from the cylinder, a fresh supply of water enters it through the inlet valve, the cylinder being placed below the surface of the supply water. This valve is contained within a well, and the supply water is admitted through a valve and grating, by which it can be stopped back out of the well at any time, for the purpose of examining the inlet valve; or the valve itself can be detached and drawn up to the top of the well, being slidden down to its place upon guide-rods, and secured by long screwed bolts that can be reached from the surface. The float is strengthened against collapsing by circular stays; and a small tube is inserted in it, reaching almost to the bottom, so that if any water should get into the interior of the float through a defective joint, it is expelled through the tube as soon as the pressure of steam is removed from the outside of the float, after filling a tender.

The apparatus is equally applicable when the supply of water is obtained from a reservoir at the foot of an embankment, from a well considerably below the level of the ground, or from running water.

In this plan of raising water by the direct action of steam pressure, it might be expected that the condensation of steam in the water cylinder would be so considerable as to interfere seriously with the working of the apparatus; but it must be borne in mind that the larger the cylinder, the smaller is the extent of surface presented for condensation, in proportion to its contents; and it has been proved by experiment that this is not a serious objection in the size of the present apparatus; while the friction and waste of power involved with the

pumps and engines now in use are obviously saved. In order to ascertain whether a locomotive boiler can afford to lose the amount of steam requisite to raise the water, especially where the lift is from 50 to 60 feet high, a boiler has been constructed of 141 gallons capacity, 69 per cent. of which was filled with water, connected by a flexible tube with a water cylinder holding 131 gallons,—the arrangement being in all respects similar to that already described; the discharge water pipe from the cylinder rose 60 feet perpendicularly, but had valves at various lower elevations. The water pipe was 4 inches diameter inside, and the steam pipe 1½ inches diameter, and the area of steam way in the tap 1·83 square inches. Many trials were made, in each of which 131 gallons of water were raised; the average height of lift being 52 feet, and the average pressure of steam in the boiler 56½ lbs. per square inch. In order to guard against too rapid a generation of steam, and to approximate to the condition of a locomotive when standing at a station, the damper remained closed during each trial. It was then found that the loss of steam pressure in raising the 131 gallons of water 52 feet high, was only 4·2 lbs. per square inch, and the time required, 32 seconds. When the damper remained open, the steam was generated more rapidly than it was used, and the pressure then rose during each trial. Hence, a locomotive just arrived at a station will always have sufficient steam to spare to refill the tender; and this will consequently be effected at the entire saving of the pumping engines, pumps, and buildings at present necessary, while the heavy expenses now incurred of attendance, repairs, and fuel, are dispensed with.

With this apparatus, there is no difficulty in working during frost; the crane and pipes being kept always empty, and the water cylinder below the ice—thus removing the danger of the pipes bursting, and obviating the necessity of keeping them thawed by the application of fires, as in the case of the present water cranes. This is a consideration of no little importance, especially in Canada and other countries subject to severe and protracted frosts. The steam that is condensed in forcing up the water is not entirely lost, as it serves slightly to warm the water which will shortly supply the boiler. It has been computed that the cost in fuel of raising 1000 gallons of water 50 feet high, by this process, is less than one halfpenny; and the plan is therefore recommended by economy, great simplicity, and rapidity of action.

Mr. A. Fryer said, he had been led to this plan by difficulties experienced in raising continually large quantities of saccharine fluids, of a specific gravity of about 1·3, which had to be raised a height of 60 feet, to the top of the sugar manufactory. Cranes were previously used to lift the bags of rough sugar to the top of the building, but this was found to be a slow and expensive process when a large amount had to be conveyed, and pumps were then employed for the purpose; the first process of dissolving the sugar in hot water being performed at the bottom of the building, and the liquid then pumped up to the top; but the pumps were found to be rapidly worn and cut by the large quantity of sand, pieces of cane, and other rubbish that was

mixed with the rough sugar, and no form of pump was able to stand the work. He then tried the direct application of the steam pressure to force up the liquid through a pipe, and found it so completely successful that the plan was adopted for the whole of the work. The dissolved sugar was put in a large close vessel, like a circular boiler, 6 feet diameter, with a delivery pipe 4 inches diameter, extending from it to the top of the building, a height of 60 feet; and steam at 40 lbs. per inch pressure was let into the upper part of the vessel, and, pressing upon the surface of the liquid, forced it instantly up the delivery pipe, the lower end of which reached to the bottom of the vessel inside. The process was effected with great rapidity, the solid refuse lying at the bottom of the vessel being swept clean out, together with the liquid. A quantity of 20,000 gallons per day was regularly raised in this way, and the solid matter carried up besides amounted to several tons per day. The vessel was recharged by condensing the steam in it by a jet of cold water upon the outside, and opening a communication with the vat in which the sugar was dissolved; the vessel then became rapidly filled, and the process of letting in the steam and expelling the contents up the delivery pipe was directly repeated. There was found to be but little waste of steam in this process, although no float was used in the vessel, and the steam was admitted direct upon the surface of the liquid; for a film of boiling water was immediately formed upon the surface of the liquid by the condensation of a small portion of the steam, which acted effectually as a non-conducting diaphragm, cutting off the communication with the colder liquid below, since there was no circulation to convey the heat downwards.

He had also made a trial of the same plan for raising water from a well 65 feet deep upon the works, in which the pump was sometimes under water, so that the valves could not be reached for repairs, and the pump was consequently stopped working; and he had succeeded in raising 100,000 gallons of water per day from the well, by that means. In this case, the rising main from the pumps, which was 18 inches diameter, had a second pipe, 4 inches diameter, inserted within it extending nearly to the bottom, and having a valve at the bottom opening upwards; the space between the two pipes was closed at the top with a steam-tight joint, and steam of 40 lbs. pressure was admitted to it from an adjoining boiler. This steam expelled the water from the space between the pipes, driving it up the centre pipe; and on shutting off the steam, a fresh supply of water entered this space by condensation of the steam, and was again expelled up the centre pipe by repeating the process.

In order to ascertain whether, in the case of filling locomotive tenders, there would be any risk of difficulty from want of sufficient steam in the engine boiler to serve for raising the water, he had tried some experiments with a small boiler disconnected from any other work, raising the water by the steam pressure, from a close vessel up a vertical stand-pipe, which had cocks fixed into the side at different levels, that could be opened successively for discharging the water.

He found that the water was discharged at 60 feet height, with a pressure of steam in the boiler of 27 lbs. per square inch, which was only slightly above the pressure required to balance the column of water. The quantity of steam required was found to be so small, that a supply of water sufficient to fill a locomotive tender was easily raised with the boiler fire checked and the damper kept closed, to correspond with the condition of a locomotive standing at a station. In applying this plan for filling tenders, his object was to employ the power available in the locomotive engine for raising the water direct, instead of requiring the erection of fixed pumping machinery and engine power at each station.

It was thought that the plan possessed many advantages. It had great simplicity, and was free from liability to derangement from frost; the saving also in first cost would be very considerable, where stationary engines had now to be employed for pumping.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM AUGUST 1, TO AUGUST 31, 1860.

Alkalies,—Preservat. of Caustic	John Seiberling,	Philadelphia,	Penna.	14
Amalgamator,	Wm. Gluyas,	San Francisco,	Cal.	7
———	James White,	Bangor,	Me.	28
Ant Trap,	Cottingham & Menefee,	Texana,	Texas,	7
Artificial Legs,	B. W. Jewett,	Gilford,	N. H.	7
Auger,	W. A. Ives,	N. Haven,	Conn.	28
Augers,—Handle Fastenings for	J. M. Hathaway,	City of	N. Y.	21
Bed Bottom,	L. W. Buxton,	Nashua,	N. H.	7
——— Slat,	J. N. Dennett,	Bath,	Me.	21
Bedstead,	Wm. Deckmann,	Canton,	Ohio,	21
———	John Leigh,	Edgefield,	S. C.	7
——— Fastening,	H. T. Smith,	Washington,	D. C.	14
Beehives,	Daniel Arndt,	Zanesville,	Ohio,	21
———	E. S. Bacon,	Albion,	N. Y.	28
———	Wm. Hyde,	Emery,	Ohio,	7
———	Samuel Maitland,	Fort Wayne,	Ind.	28
———	C. Williams,	Weston,	Mo.	28
Bells,—Apparatus for Ringing	James Harrison,	Troy,	N. Y.	28
Belt-shipper,	J. C. Goar,	Monterey,	Cal.	14
Black-boards,—Composition for	J. B. Rowell,	Lynn,	Mass.	7
Blanks,—Machine for Rolling	N. C. Lewis,	Boston,	"	7
Blind Rods,—Wiring	Jacob Coover,	Chambersburg,	Penna.	7
Boiler Tubes,—Drawing	S. J. Perry,	Columbia,	S. C.	21
Books and Paper,—Trimming	Gabriel Utley,	Chapel Hill,	N. C.	7
Boots & Shoes,—Manufacture of	L. R. Blake,	Abington,	Mass.	14
———	"	"	"	14
Bottles,	J. N. Bodine,	Bridgeton,	N. J.	14
———	John Maurer,	City of	N. Y.	14
———,—Apparatus for Filling	C. A. Gregory,	Poughkeepsie,	"	28
Boxes,—Cutting	C. Sewerkrop,	Louisville,	Ky.	7
Brakes,—Car	H. W. Norvill,	Livingston,	Ala.	21
———,—Carriage	Edward Behr,	City of	N. Y.	7
———,—Railroad Car	Walter Somerville, Jr.,	Mitchell Stat.,	Va.	21
———,—Self-acting Wagon	George Buchanan,	Hickory,	Penna.	28
Bread Slicer,	L. W. Baker,	Marlboro',	Mass.	14
Breast Pumps,—Construction of	J. H. Beadle,	City of	N. Y.	21

Brick Machines,	W. S. Wallace,	Americus,	Ga.	28
———	Wm. Wood,	Hartford,	Conn.	14
Burglar Alarm,—Clock and	G. K. Proctor,	Beverly,	Mass.	7
Butter-worker,	L. S. Ingraham,	Grafton,	Ohio,	7
Candle-wicks,	J. H. Tatum,	City of	N. Y.	21
Candles,—Machinery for Mould.	Ferdinand Meyrose,	St. Louis,	Mo.	7
Cane-coverers,	E. H. Angamar,	New Orleans,	La.	28
Cans,—Exhausting and Sealing	W. Y. Gill,	Henderson,	Ky.	14
——,—Grooves in Necks of	J. D. Willoughby,	Petersburg,	Va.	21
Car Register,	L. H. French,	Philadelphia,	Penna.	28
—— Seats and Couches,	David Pennoyer,	North East,	N. Y.	28
Cars,—Iron	Richard Montgomery,	City of	"	7
——,—Sleeping	J. B. Sutherland,	Detroit,	Mich.	14
Carriages,—Exten. of Seats for	J. A. Naylor,	Rahway,	N. J.	21
Cattle Ties,	George Hull,	Port Crane,	N. Y.	28
Chair Bottom,—Metallic	Volney Stockton,	Williamsburgh,	Ohio,	7
——,—Folding	J. H. Swan,	City of	N. Y.	21
Cheese Cutter,	J. G. Barker,	Watertown,	Mass.	14
——— Hoops,	H. A. Roe,	Madison,	Ohio,	28
Chuck and Counter-sink,	Daniel Argerbright,	Gratis,	"	21
Churn,	J. M. Buell,	Zanesville,	"	7
———	Hutchins & Leach,	Penobscot,	Me.	14
Clothes Dryer,	Ransom Gilbert,	Morrisville,	Vt.	28
———	D. K. Hickok,	"	"	21
———	Josee Johnson,	City of	N. Y.	14
Coal,—Separating Slate from	L. P. Garner,	Ashland Bor'h,	Penna.	7
Coffee Roaster,	R. Little,	Middle Branch,	Ohio,	28
Coloring Matter from Oak Bark,	Carl Henrichs,	City of	N. Y.	7
Cooking Range,	E. G. Niles,	Cincinnati,	Ohio,	21
Cork-drawer,	Chas. Alexander,	Washington,	D. C.	7
Corn Planters,	F. G. and E. A. Floyd,	Macomb,	Ill.	28
———	J. S. Fowler,	Peoria,	"	14
———	Aaron Miller,	Brockport,	N. Y.	14
———	D. and H. Wolf,	Lebanon,	Penna.	28
———	C. L. Waffle,	Sharon,	Ohio,	21
—— Shellers,	George Danforth,	Friendsville,	Ill.	21
—— Stalk Cutters,	J. R. Marshall,	Marine,	"	21
Cotton Bales,—Fastenings for	J. W. Evans,	City of	N. Y.	21
——— Gins,	A. H. Burdine,	Chulahoma,	Miss.	28
———	John Goulding,	N. Wilbraham,	Mass.	28
——— Presses,	J. C. Sellers,	Woodville,	Miss.	28
Couplings for Belts,	Chas. Fairfax, Jr.,	Cincinnati,	Ohio,	21
———,—Car	R. S. Potter,	Chicago,	Ill.	28
———	L. H. Shular,	Crawfordsville,	Ind.	7
Coupling,—Hose	George Hancock,	Providence,	R. I.	7
Couplings,—Railroad Car	W. H. H. Miller,	Williamsport,	Penna.	28
Crimping Machines,	David Bissell,	Detroit,	Mich.	28
Cultivators,	Thomas Black,	Princeville,	Ill.	28
———	Schuyler Goldsmith,	Wataga,	"	14
———	L. E. Hawkins,	Sangamon,	"	14
———	E. S. Huff,	Zanesville,	Ohio,	28
———	Lewis Leber,	Springfield,	Ill.	21
———	T. W. McDill,	Oquawka,	"	21
———	Mark Rigell,	Dawson,	Ga.	14
———	Jackson Shannon,	Dakota,	Wis.	14
———	Taylor & Graves,	Fort Adams,	Miss.	14
———	Ephraim Wells,	Auburn,	"	28
———	Ferdinand Wolf,	Brooklyn,	N. Y.	14
———	G. W. N. Yost,	Yellow Springs,	Ohio,	28
———,—Cotton	J. L. Middlebrooks,	Salem,	Ga.	7
Cupboard and Sink,	Anthoni Ike,	Lancaster,	Penna.	7
Cutlery,—Handles for	Matthew Chapman,	Greenfield,	Mass.	7

Decolorizers,—Compounds as	P. M. Belton,	Brooklyn,	N. Y.	14
Deep Sea Sounding Meter,	J. M. Brooke,	U. S. N.		7
Distillers Mash Tubs,—Constr.	D. P. Patterson,	Fayette co.,	Penna.	21
Ditching Machines,	A. S. Ballard,	Mt. Pleasant,	Iowa,	14
Doors Open,—Holding	Arthur de Witzleben,	Washington,	D. C.	28
Drain Tiles,—Bottom Plates for	John Parsons,	Cleveland,	Ohio,	7
Drain Tile Machines,	Gottlieb Graessle,	Hamilton,	"	14
Drills,—Rock	David Ralston,	Carlisle,	Penna.	21
Elevators for Store-houses,	W. H. Allen,	Brooklyn,	N. Y.	28
Files,—Machines for Cutting	Wm. Van Anden,	Poughkeepsie,	"	14
Fire Arms,—Projectiles for	Cranston & Bates,	New London,	Conn.	14
———,—Rammers for Revol.	C. R. Alsop,	Middletown,	"	7
—— Escape,	O. F. Burton,	City of	N. Y.	7
Flasks for Casting Iron Columns,	Henry Demmick,	"	"	21
Flour,—Device for Bolting,	Wm. Halderman,	Freeport,	Ill.	7
Fodder,—Machine for Cutting	P. S. Clinger,	Conestoga Cen.	Penna.	14
Foot-scrapers,	E. G. Burger,	Ypsilanti,	Mich.	14
Fruit Cans,—Sealing	Cooper & Haller,	Carlisle,	Penna.	7
—— Jars,	J. C. Baker,	Mechanicsburg,	Ohio,	14
Furnaces,	D. T. Woodrow,	Cincinnati,	"	28
———,—Feeding Sawdust to	Samuel Kennedy,	Hibbetts,	"	28
——— for Heating Buildings	W. H. Churchman,	Janesville,	Wis.	14
Gas,—Apparatus for Compress'g	W. H. Gwynne,	City of	N. Y.	7
—— Burners,	A. G. Hamaker,	Peoria,	Ill.	7
—— Meters,	Nathaniel Tufts, Jr.,	Boston,	Mass.	14
———	Wilson & Fox,	Reading,	Penna.	21
—— Pipe-cutter,	Wm. Kenyon,	Steubenville,	Ohio,	14
Gate,	H. A. House,	Brooklyn,	N. Y.	21
——	D. E. Fenn,	Tallmadge,	Ohio,	28
——	Wm. McAfee,	Summerville,	Mich,	21
Gearing,	A. M. Street,	Denmark,	Tenn.	14
Girders,—Trussed Compound	J. A. Roebling,	Trenton,	N. J.	28
Glass Vessels,—Attach. Covers to	R. D. Bryce,	E. Birmingham,	Penna.	21
———	Reighard & Knecht,	Birmingham,	"	21
———,—Metallic Covers	John Bird,	"	"	21
Globe,—Auto. Terrestrial Time	F. S. Barnard,	City of	N. Y.	28
Glue,—Machines for Cutting	Thomas Brown, Jr.,	S. Danvers,	Mass.	7
——,—Preparation of	J. M. Hunter,	City of	N. Y.	14
Gold Chains,—Making	Isaac Lindsley,	Providence,	R. I.	7
—— Pens,—Rolling	Alexander Morton,	City of	N. Y.	28
—— Washer and Amalgamator	J. C. Dickey,	Saratoga Spr's,	"	28
Grain Separators,	N. A. Patterson,	Kingston,	Tenn.	28
Grinding Grain and Apples,	C. B. Hutchinson,	Auburn,	N. Y.	7
Grubbing Machines,	J. B. Ash,	Elkton,	Md.	21
Guns,—Cane	Armenius Davis,	Shelbyville,	Ind.	21
Hammers,	Reinhold Boeklen,	Brooklyn,	N. Y.	28
Hand-cuff,	Wm H. Kimball,	Augusta,	Me.	7
Harrows,	M. D. Meriwether,	Denmark,	Tenn.	28
Harvesters,	George Farmer,	Osceola,	Fla.	21
———	J. H. Irwin,	Beardstown,	Ill.	21
———	F. H. Manny,	Rockford,	"	28
———	W. S. Stetson,	Baltimore,	Md.	14
———,—Auto. Rakes for	I. C. Twining,	Wrightstown,	Penna.	14
———,—Grain	Chas. Marston,	Viroqua,	Wis.	14
Harvesting Machines,	J. H. Maydole,	Eaton,	N. Y.	7
Hat-bodies,—Forming	Wm. Fuzzard,	Charlestown,	Mass.	7
Heating & Cooking Apparatuses	Edward Conway,	Dayton,	Ohio,	28
——— Rooms,—Device for	Lewis Newsom,	Gallipolis,	"	21
Hinges,—Spike for	Henry Garrett,	Richmond,	Mo.	7
Horse-shoe Nails,—Machine for	Amos Whittemore,	Cambridgeport,	Mass.	14
Horses Hoofs,—Paring	Abraham Baker,	Shenandoah co.,	Va.	7

Insects,—Appa's for Destroying	Adolph Isaacsen,	City of	N. Y.	21
Ink Bottles,—Case for Indelible	Edward Daniels,	Southampton,	Mass.	7
Iron Bars, &c.,—Rolling	Bernard Lauth,	Pittsburgh,	Penna.	21
Joists,—Machine for Dressing	J. H. Story,	Cincinnati,	Ohio,	21
Journal Boxes,	Montgomery Queen,	Brooklyn,	N. Y.	28
Knitting Machines,	Walter Aiken,	Franklin,	N. H.	7
Lamps,	George Blanchard,	City of	N. Y.	7
———	T. B. Smith,	Marietta,	Ohio,	28
———	J. T. Williams,	York Borough,	Penna.	28
Lanterns,	T. B. De Forest,	City of	N. Y.	7
Lathe,	B. D. Whitney,	Winchendon,	Mass.	7
Leather-splitting Machines,	J. F. Flanders,	Boston,	"	14
Life-boat,	Samuel Mills,	City of	N. Y.	7
Lock,	Wm. H. Greenwood,	Galva,	Ill.	14
Locom. Engs.,—Dispos'g Sparks	L. P. Teed,	Wh. Deer Mills,	Penna.	7
———,—Water-heater	S. F. Allen,	Chicago,	Ill.	7
Lubricator,	E., B., & T. S. Parker,	Schenectady,	N. Y.	7
Manganese,—Manu. of Oxyd for	C. T. Dunlop,	Glasgow,	N. Brit.	7
Marking Stock,—Mode of	John Merry,	Eldorado co.,	Cal.	14
Mattress,—Spring	Herrmann Jury,	City of	N. Y.	14
———	Whitehead & Kettle,	"	"	28
Meat and Vegetable Chopper,	L. S. Chichester,	"	"	28
Metallic Alloy for Journals,	George Sherman,	Memphis,	Tenn.	7
Military Caps,	J. S. Smith,	City of	N. Y.	21
Mill,—Grinding	Daniel Read,	Hamilton,	"	7
——,—Sugar-grinding	G. J. Rice,	Frederick City,	Md.	14
Mills,—Gig	James Shaw,	Manayunk,	Penna.	28
—— for Cutting and Grinding,	Evariste Mire,	New Orleans,	La.	7
——,—Grinding	P. G. McCulla,	Philadelphia,	Penna.	14
——,—Portable,	Nelson Burr,	Batavia,	Ill.	7
——,—Quartz	J. C. Davis,	San Francisco,	Cal.	7
——,—Sugar Cane,	H. T. Douglas,	Zanesville,	Ohio,	28
Millstones,—Curb for	O. L. Richardson,	Athens,	Ga.	14
———,—Machines for Pick'g	John Kelly,	W. Milton,	Ohio,	21
———,——— Dress'g	S. K. Landes,	W. Cocalico,	Penna.	21
Molding Machine,—Shaping &	H. D. Stover,	City of	N. Y.	21
Mop-holder,	B. W. Bruel,	Beloit,	Wis.	14
Nail Head,—Picture	J. B. Sargent,	New Britain,	Conn.	21
—— Plate-feeders,	Wm. Riley, Jr.,	Reading,	Penna.	14
Nails,—Cleansing, &c., Galvan.	Wm. Blake,	Boston,	Mass.	21
Omnibus Registers,—Self-lock'g	Michael Offley,	Baltimore,	Md.	7
Ores,—De-oxydizing	Isaac Rogers,	N. Haverstraw,	N. Y.	21
Ovens,	J. M. Read,	Boston,	Mass.	28
Oxychloride of Lead,—Making	Ludwig Brumlen,	Hoboken,	N. J.	21
Paddle Wheels,—Fastening for	Ezra Reid,	Bazetta,	Ohio,	28
Paint Can,	E. A. Leland,	Brooklyn,	N. Y.	14
Paper Pulp,	F. De Compoloro,		France,	7
—— Stock,—Manu. of Leather	E. and J. R. Cushman,	Amherst,	Mass.	21
Pavements, &c.,—Composition	George Scrimshaw,	Milesburg,	Penna.	21
Photographic Camera,	August Semmendinger,	City of	N. Y.	7
——— Medal,	D. F. Maltby,	Waterbury,	Conn.	14
Piano-forte,	Herman Linderman,	City of	N. Y.	7
——— Keys,	C. J. Schoenemann,	"	"	7
Picture Frames, &c.,—Enamel'g	Robert Marcher,	"	"	14
Pipes,—Cleansing Galvan. Iron	Wm. Blake,	Boston,	Mass.	21
——,—Construc. & Joining of	T. S. Truss,	Darlington,	Engl'd,	21
Planing Machine,	H. D. Stover,	City of	N. Y.	21
———,—Cutter-head for rotary	"	"	"	14
———	Theodore Christian,	"	"	28

Ploughs,	J. P. Bond,	Greenwood,	S. C.	14
———	L. D. Burch,	Sherburne,	N. Y.	14
———	Samuel Canterberry,	Holmes co.,	Miss.	14
———	J. S. Hall,	W. Manchester,	Penna.	14
———	"	"	"	14
———	A. Roden,	Talladega,	Ga.	28
———	James Smith,	Norfolk,	Va.	14
———	P. H. Starke,	Richmond,	"	21
———	Bancroft Woodcock,	Williamsburgh,	Penna.	21
———	W. E. Wormell,	Germantown,	Tenn.	28
———,—Adjustable Moles for	Lathrop Kazar,	Leroy,	Ill	14
———,—Hillside	Miller & Henry,	Cincinnati,	Ohio,	21
Post Holes,—Machs. for Digging	A. W. Porter,	St. Johnsville,	N. Y.	7
Presses,	L. W. Harris,	Waterville,	"	28
———	A. Roden,	Talladega,	Ala.	21
Press,—Copying	C. F. Grabo,	Boston,	Mass.	14
——,—Cotton	P. B. Wever,	Scarborough,	Ga.	21
Presses,—Printing	J. E. Briest,	St. Louis,	Mo.	28
———————	G. F. Hebard & others,	Buffalo,	N. Y.	7
———————	Wells & Barth,	Cincinnati,	Ohio,	7
———————	Thomas Hall,	St. Louis,	Mo.	7
Propeller for Canal Boats,	Edward Backus,	Rochester,	N. Y.	21
———,—Marine	G. L. Carver,	Brazil,	S. A.	7
——— Shafts,—Rollers for	Daniel S. Chase,	Augusta,	Ga.	14
Pruning Trees,—Instruments for	D. P. Chamberlin,	Hudson,	Mich.	7
Pumps,	Joseph Hardey,	Moline,	Ill.	21
———,—Chain,	Amos Coates,	Marlborough,	Ohio,	7
———	Wm. Shearer,	Atlanta,	Ga.	21
Quadrants,—Sinecal	A. M. Chisholm,	Antigonish,	N. S.	28
Quilting Frame,	J. L. Newton,	Black Brook,	N. Y.	28
Railroad Car Springs,	G. L. Turner,	City of	"	21
——————— Windows,	Messer & Steinbrenner,	Cleveland,	Ohio,	14
——— Cars,—Journal-boxes	Harvey Rice,	Concord,	N. H.	7
——— Car Wheels,	Walter Youmans,	Waterford,	N. Y.	7
——— Cars,—Stop. & Start.	F. C. Kutt,	Hackensack,	N. J.	21
———————————	J. H. Wygant,	"	"	7
——— Switch,—Safety	H. N. Rhodes,	Richmond,	Vt.	28
——— Switches,—Operating	Simeon Heywood,	Claremont,	N. H.	28
———————————	G. K. Hyde,	Brooklyn,	N. Y.	28
Railroads,—Construction of	Alexander Hay,	Philadelphia,	Penna.	21
————,—Sliding Switches for	H. N. Rhodes,	Richmond,	Vt.	28
Railway Bars,—Lock Joint for	Aaron Douglass,	Paterson,	N. J.	21
Rakes,—Horse	G. S. Kinsey,	Reading,	Penna.	28
Reaping Grain & Mowing Grass,	A. A. Henderson,	Huntingdon co.,	"	14
Reaping and Mowing Machines,	"	Philadelphia,	"	14
———————————	Elizabeth M. Smith,	Burlington,	N. J.	7
Refrigerator,	D. S. Heffron,	Utica,	N. Y.	7
Rice,—Machine for Cleaning	James Van Valkinburgh,	Binghampton,	"	21
——,—Machines for Hulling,	C. B. Horton,	Elmira,	"	28
Rotary Engines,	H. E. Emery,	Lincoln,	Ohio,	7
———————	Cornelius Donovan,	E. Abingdon,	Mass.	7
———————	B. A. Goodell,	Millbury,	"	14
———————	P. B. Holmes,	Cincinnati,	Ohio,	28
——— Motion,—Reciprocat'g to	Elisha Matteson,	Brooklyn,	N. Y.	28
Rubber,—Devulcanizing Waste	A. C. Richard,	City of	"	21
Sack-fastener,	Thomas Hopkins,	Newport,	Ky.	21
Sad-iron,	W. M. Knight,	Buffalo,	N. Y.	28
Sails,—Working Ships	A. L. Simpson,	Durham,	N. H.	28
Sausage-filler,	J. G. Perry,	S. Kingston,	R. I.	28
Saw Blades,—Mach. for Grind'g	Henry Disston,	Philadelphia,	Penna.	21
——,—Reciprocating	Christian Germann,	Camden,	Mich.	21

14	Saw-set,	Wm. Clemson,	Middletown,	N. Y.	21
14	Sawmills,—Feed Motion for	E. G. Dyer,	Hamilton,	Ohio,	21
14	———,—Head Block for	J. W. Truax,	Richford,	Vt.	28
14	Saw Teeth,—Mach. for Setting	T. S. and H. Disston,	Philadelphia,	Penna.	28
14	Saws,—Tempering	Wm. Clemson,	Middletown,	N. Y.	21
28	Sawing Stone,—Machines for	A. M. Burnham,	Montpelier,	Vt.	21
14	Scaffolds,—Portable	R. M. Lytle,	Triune,	Tenn.	14
21	Screw Augers,—Casting	Carl & Heath,	Grenada,	Miss.	21
21	Scythe Fasteners,	C. L. Barritt,	City of	N. Y.	21
28	Seaming Machines,—Double	G. R. Moore,	Pittsburgh,	Penna.	28
14	Seeding Machines,	James Alsop,	Clinton,	Ill.	28
21	————	Edward Badlam,	Ogdensburgh,	N. Y.	28
7	————	Wm. S. Lawyer,	Gratiot,	Ohio,	7
28	————	M. H. Mansfield,	Ashland,	"	28
21	————	McElroy & Kimble,	Fox Lake,	Wis.	7
14	Seed Planters,	Leonard Harriman,	Anderson,	Ind.	21
21	————	J. P. Allen,	Dover,	Ga.	14
28	————	T. M. Green,	Milledgeville,	"	21
7	————	James McLaughlin,	Duncannon,	Penna.	28
7	————	J. R. Mills,	Bloomfield,	Iowa,	28
7	————	W. F. Schroeder,	La Porte,	Ind.	14
21	————	J. F. Tannehill,	Staunton,	Va.	14
7	————	Miller Warren,	W. Middleburg,	Ohio,	21
14	Sewing Machines,	David Haskell,	Georgetown,	Mass.	28
7	——— Machine Needles,	F. H. Drake,	Middletown,	Conn.	14
21	Ships Berth,—Oscillating	T. S. Brown,	Philadelphia,	Penna.	28
7	Shirt Stud,	Wm. F. Kubler,	City of	N. Y.	7
21	Shoe Cleaner,	Thomas Board,	Ripley,	Va.	28
28	—— Pegs,—Mach. for Pointing	S. G. Brett,	Newport,	N. H.	14
28	—— Pegging Machine,	C. A. Priest,	Winslow,	Me.	7
	—— Tips,—Cutting & Swaging	Bearce & Peck,	N. Auburn,	"	28
21	Shutters & Awnings for windows,	Jacob David,	City of	N. Y.	21
14	Sofa Bedstead,	Tendler & Moeshlin,	Cambridge,	Mass.	28
7	Spading Machines,	Stuart Gwynn,	City of	N. Y.	28
7	Spinning Frames,—Driv. Bands	Slade & Scranton,	Bennington,	Vt.	7
21	————,—Tubes for	D. D. Allen,	S. Adams,	Mass.	7
7	Spoons,—Mach. for Burnishing	H. M. Jacobs,	Hartford,	Conn.	14
28	Springs,—Carriage	G. H. Laub,	Newark,	Mo.	14
28	———,—Wagon	Nicholas Jenkins,	City of	N. Y.	14
28	Stalk and Root-cutters,	Frederick Fidler,	Batavia,	"	28
21	Steam,—Method of Generating	Stuart Gwynn,	City of	"	7
28	——— Boilers,	G. W. Rains,	Newburg,	"	14
21	————,—Low-wat. Alar.	C. H. Brown,	Fitchburgh,	Mass.	7
28	——— Engines,	G. W. Van Deren,	Big Flats,	N. Y.	14
14	————,—Condensers	B. F. Lemmon,	New Albany,	Ind.	7
14	————,—Governors for	C. P. Buckingham,	Mt. Vernon,	Ohio,	7
7	————————	R. W. Gardner,	Quincy,	Ill.	14
7	————,—Pistons for	H. D. Dunbar,	Memphis,	Tenn.	14
21	————————	Robinson & Clark,	Bellaire,	Ohio,	14
28	————,—Slide Valves	L. P. Rice,	Adrian,	Mich.	28
7	————,—Valve Gear	Patrick Kenney,	Providence,	R. I.	14
7	————————	Peter Louis,	City of	N. Y.	28
14	——— Gauges,	Albert J. Allen,	Buffalo,	"	14
28	Steering Apparatus,	Nathaniel Snow,	Boston,	Mass.	14
28	Stop-cocks,	H. A. Chapin,	Springfield,	"	21
21	Stoves,	Wm. F. George,	Cincinnati,	Ohio,	21
21	———	Magee & Towne,	Lawrence,	Mass.	14
28	———	J. S. and M. Peckham,	Utica,	N. Y.	7
28	———	J. Stuber and others,	"	"	7
28	Straw-cutters,	D. B. Caldwell,	Cincinnati,	Ohio,	7
21	————	E. D. Lady,	Nashville,	Tenn.	28
21	Stump Extractors,	J. B. Lyons,	Milton,	Conn.	14

Stump Extractors, .	Wm. & Daniel Kimmel,	Cambridge C'y,	Ind.	14
Surveyors Instrument,	Able Ware, .	Athens,	Me.	28
——— Leveling Instruments,	Lorenzo Lea, .	Jackson,	Tenn.	21
——— Measure,	W. H. Paine, .	Sheboygan,	Wis.	7
Sweeping Machine,—Street	Jacob Edson, .	Boston,	Mass.	14
Table,—Circular .	J. F. Finger, .	Marion,	S. C.	24
Tacks,—Applying Washers to	J. G. Howard, .	S. Braintree,	Mass.	28
Tanks,—Construction of Stone	L. B. Darling, .	Providence,	R. I.	21
Tanning,—Compositions for	Alexander Hill, .	Dubuque,	Iowa,	7
——— Apparatus,—Construc.	Dennis Aldrich,	St. Louis,	Mo.	21
Telegraphic Apparatuses,	L. Bradley, .	City of	N. Y.	28
——— Instruments,	David Flannery,	Jackson,	Miss.	21
——— .	E. F. Reynolds, .	West Farms,	N. Y.	21
Telegraphs,—Lightning-arrester	D. F. S. Ways, .	Baltimore,	Md.	7
Tenoning Frame, .	Asa Greenwood, .	Toulon,	Ill.	14
Thills to Vehicles,—Attaching	E. H. Plant, .	Plantsville,	Conn.	14
Thread,—Dressing and Finish'g	Hall & Merrick, .	W. Willington,	"	21
——— .	" .	"	"	7
Threshing Machines,—Cylinders	L. and E. Whitman,	Winthrop,	Me.	21
Tires,—Machine for Bending	Wm. Bailey, .	London Grove,	Penna.	14
Tire,—Machine for Upsetting	Orlando Foster, .	Kenosha,	Wis.	7
———	Olmstead & Walker,	Victoria,	Ill.	7
———	C. V. Statler, .	Wataga,	"	7
Tool Handles, .	J. G. Rogers, .	San Francisco,	Cal.	14
Trace-fastener, .	Sylvenus Walker, .	Boston,	Mass.	28
Traps,—Animal .	George Slusser, .	Hillsboro',	Ohio,	14
Trap,—Steam .	Nehemiah Upham, .	Norwich,	Conn.	28
Tree Protector, .	W. W. Taylor, .	S. Dartmouth,	Mass.	21
Trunks, .	S. Bourne, Jr., .	City of	N. Y.	7
Trusses,—Construct. of Hernial	L. B. White, .	Moscow,	"	21
Turbine Water Wheels, .	Bradford Stetson, .	Uxbridge,	Mass.	14
Umbrellas, .	J. P. Schenkl, .	Boston,	Mass.	21
Vinegar,—Manufacture of	John Palmer, .	Fort Scott,	Kansas,	7
Washing Machine,	S. T. and David Adams,	Medina,	Ohio,	21
——— .	J. S. Davis, .	Tiffin,	"	14
———	Hugunin & Whitney,	Cleveland,	"	21
——— .	Solomon Hunt, .	Danville,	Ind.	28
———	Patterson & Ramsey,	Kingston,	Tenn.	21
——— .	H. E. Smith, .	Philadelphia,	Penna.	28
———	A. Threlkeld, .	Boone co.,	Ind.	14
Washstand,—Fountain .	J. R. Ender, .	Trenton,	La.	7
Watches,—Lever Escapement	John Devlin, .	Philadelphia,	Penna.	14
Water Elevators, .	Hiram Nash, .	Maysville,	Ky.	7
——— from Wells,—Delivering	James Dakin, .	Cleveland,	Ohio,	21
——— Wheels, .	John Blocher, .	Williamsville,	N. Y.	7
——— .	Adolphus Lind, .	San Francisco,	Cal.	7
——— .	H. G. Nelson, .	Lockport,	N. Y.	28
Wheels for Vehicles,	T. C. Hendry, .	Conyers,	Ga.	7
———,—Holder for Polishing	E. W. Nichols, .	Worcester,	Mass.	7
Willow-peeler, .	J. M. Wood, .	Seneca,	N. Y.	7
Window Shade Fixture, .	R. B. Burchell, .	Brooklyn,	"	7
——— Washer, .	John Middleton,	City of	"	28
Wrenches, .	E. S. Scripture, .	"	"	28
Wrench and Pincers,	Ezra Ripley, .	Troy,	"	14
——— Vise, .	Wm. Russell, .	Stoughton,	Mass.	14

EXTENSIONS.

Brides,—Truss .	Wm. Howe, .	Springfield,	Mass.	28
Screws,—Cutting Wood .	T. W. Harvey, .	City of	N. Y.	28
———,—Wood .	T. J. Sloan, .	Paris,	France,	28

ADDITIONAL IMPROVEMENTS.

Churn,	M. L. Bauder,	Cleveland,	Ohio,	7
Lamps,	Alburtus Geiger,	Dayton,	"	14

RE-ISSUES.

Fire Arms,—Revolving	J. M. Cooper,	Pittsburgh,	Penna.	21
—— Plugs,	J. L. Lowry,	"	"	21
Gases,—Appa's for Naphthaliz'g	E. H. Ashcroft,	Boston,	Mass.	14
Hat-bodies,—Mach. for Making	A. B. Taylor,	City of	N. Y.	21
Lamp Shades,	Chas. & A. C. Wilhelm,	Philadelphia,	Penna.	21
Shoes,—Wooden-soled	Henry Wight,	Cambridge,	Mass.	7
Steam Boilers,—Safety Apparat.	Timothy Clark,	Bedford,	N. Y.	28
Stoves,	P. N. Burke,	Buffalo,	"	21
Water from Wells,—Drawing	J. W. Wheeler,	Cleveland,	Ohio,	21

DESIGNS.

Carpet Patterns (3 cases),	E. J. Ney,	Lowell,	Mass.	7
—— 8 "	H. G. Thompson,	City of	N. Y.	7
Coffins,	J. P. Cunningham,	Franklin,	Tenn.	14

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, October 19, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Geographical Society.

Donations to the Library were received from the Royal Society, the Royal Geographical Society, the Statistical Society, and the Chemical Society, London; L. A. Huguet Latour, Esq., Montreal, Canada; W. H. Schock, Esq., U. S. Navy, Baltimore, Maryland; Frederick Emmerick, Esq., Washington D. C.; J. Disturnell, Esq., Alfred W. Craven, Esq., City of New York; G. B. Prescott, Esq., Boston, Mass.; and from Messrs. A. L. Elwyn, Francis Wharton, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of September was read.

The Board of Managers and Standing Committees reported their minutes.

Twenty resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (18) were proposed, and the candidates proposed at the last meeting (9) duly elected.

Mr. J. E. Wootten exhibited a model of Andrews and Carr's patent Lubricator for car journals or other end bearings. It consists in introducing the oil for lubrication into a chamber formed by boring a

cylindrical hole into the end of the axle of a depth about equal to the length of the journal. A small hole is bored from the surface of the journal to communicate with the chamber, and through this orifice the oil reaches the bearing. A tube for containing oil fills the chamber. Upon the insertion of this tube with its charge of oil, the chamber is closed by means of an annular screw-plug, in which is inserted a disk of plate glass, which serves the admirable purpose of affording an opportunity of observing at a glance what quantity of oil the chamber contains, and when the supply should be replenished. Experimental tests which have been made with this lubricator, show it to be very economical and efficient in its performance.

A Seed-planter and Horse-rake combined, was presented to the notice of the members. It is patented by Russell & Wiley, of Chester co., Pa., and is claimed to have the following advantages :—

1st. It can be used as a grain drill, sowing, with much accuracy, wheat and oats.

2d. With a little alteration, it is changed to a corn planter, either checkering the grain, or sowing it in one continuous line.

3d. It can be changed in a few minutes time into a horse-rake.

4th. It also has a grass-seed sower attached.

The patentees say, that the machine can be furnished at the same price as an ordinary grain drill.

Mr. Howson exhibited a specimen of Messrs. Dietrich and Bridge's Patent *Hose Protector*. It consists of two sheets of gum elastic or other equivalent flexible material fastened together at one end, the lower sheet being furnished with transverse strips. When a fire occurs in the neighborhood of streets having railways traversed by passenger cars, two of these patent hose protectors are placed one on one rail, and the other on the opposite rail of the track. The upper sheets of the protectors are then thrown back, the lower sheets placed beneath the hose, and the upper sheets folded over the latter. The cars are then allowed to pass over the protectors, which serve to prevent the wheels from injuring the hose or interrupting the flow of water through the same, the direct course of the cars being in no way interfered with. These protectors have been submitted to such practical tests as fully prove their efficiency.

BIBLIOGRAPHICAL NOTICE.

History, Theory, and Practice of the Electric Telegraph. By George B. Prescott. Boston: Ticknor & Fields, 1860.

The subject of this well-written work is one of great interest to an American, not only on account of its practical importance, but because he may legitimately feel proud of the numerous and valuable improvements in it, which are due to his countrymen. The work of Mr. Prescott gives a very good account of the electric telegraph. It contains a very full description of the principal inventions in the art, and these

descriptions are concise, lucid, and abundantly illustrated by excellent wood-cuts. There is every evidence of a disposition to be fair toward all inventors, American and foreign;—so that although we think a very manifest bias against Mr. Morse is shewn, yet we doubt not, it was quite unintentional in the writer. If, however, he believes that Mr. Morse did not devise the local circuit, it would have been more instructive for us, if he had shown us who did and when. But, after all, this bias does not prevent a very fair account of what Morse's Telegraph is, and what Mr. Morse claims, which is all the public generally want to know. The book is of course excellently got up by the publishers, and will constitute a very valuable addition to the libraries of those who want to know the history and the theory of the electric telegraph.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

SEPTEMBER.—The temperature of the month of September was a little more than two degrees below the average temperature for the last ten years, and about half a degree below the average of September, 1859. The daily oscillation, as well as the mean daily range of temperature, was greater than usual.

The warmest day was the 8th, of which the mean temperature was 80·3°. The highest degree indicated by the thermometer was 92°, on the same day. From two o'clock on the afternoon of the 8th, till the same hour on the 9th, the temperature fell 24°.

The temperature was lowest on the night of the 29th, when the register thermometer indicated 42°; and the next day, the 30th, was the coldest day of the month, the average temperature of that day being 48·3°.

The pressure of the atmosphere was greater than usual, the average height of the barometrical column being thirteen hundredths of an inch higher than for September, 1859, and nearly three hundredths of an inch higher than the average for the last ten years.

The barometric column stood highest on the evening of the 30th, when it indicated 30·313 inches, after being reduced to the temperature of 32°. It was lowest on the afternoon of the 25th, when it marked 29·597 inches.

The force of vapor and the relative humidity were again below the average.

There was but one day of the month on which the sky was completely clear or free from clouds, and not one on which the sky was entirely covered with clouds at the hours of observation.

Rain fell at Philadelphia on seven days of the month, to the aggregate depth of 2·907 inches, which is nearly an inch below the average for the month, and five inches less than the amount which fell in September of last year.

The equinoctial storm, visited us in the shape of a heavy shower of rain on the morning of the 20th. It commenced at half past one, and ceased at half past six, during which time an inch and three-quarters of rain fell. Several showers also fell between four and half past ten in the evening, accompanied with thunder and lightning. No damage whatever was sustained at Philadelphia, though the papers from other parts of the country record the destruction of a considerable amount of property by wind and flood. From the 11th till the 14th, a large quantity of rain fell in parts of New York and New England. On the 15th, there was a terrible storm in the Gulf of Mexico, the wind first from the north-west and then from the north, causing the loss of some very valuable merchant ships. At Mobile, the water rose far above the wharves and above the level of the streets, and destroyed a great quantity of merchandize. On the evening of the 19th, another heavy rain storm commenced, and extended from the Hudson River to beyond Lancaster, Pa.

The first appearance of hoar frost observed this season, was on the morning of the 28th.

The winds during the month, as will be seen by the following table of comparisons, were more southerly than usual.

A Comparison of some of the Meteorological Phenomena of September, 1860, with those of September, 1859, and of the same month for ten years, at Philadelphia.

	Sept., 1860.	Sept., 1859.	Sept., 10 years.
Thermometer.—Highest,	92°	82°	95°
" Lowest,	42	45·5	39
" Daily oscillation,	18·20	18·10	17·00
" Mean daily range,	5·20	4·10	4·80
" Means at 7 A. M.,	60·28	61·02	62·58
" " 2 P. M.,	73·17	72·88	74·91
" " 9 P. M.,	64·02	64·65	66·63
" " for the month,	65·82	66·18	68·04
Barometer.—Highest,	30·313 in.	30·179 in.	30·430 in.
" Lowest,	29·597	29·338	29·338
" Mean daily range,	·143	·119	·121
" Means at 7 A. M.,	30·003	29·875	29·985
" " 2 P. M.,	29·965	29·835	29·943
" " 9 P. M.,	29·998	29·863	29·961
" " for the month,	29·989	29·858	29·963
Force of Vapor.—Means at 7 A. M.,	·425 in.	·438 in.	·474 in.
" " " 2 P. M.,	·437	·462	·494
" " " 9 P. M.,	·455	·472	·515
Relative Humidity.—Means at 7 A. M.,	77 per ct.	79 per ct.	79 per ct.
" " " 2 P. M.,	50	59	55
" " " 9 P. M.,	72	76	74
Rain, amount in inches,	2·907	7·779	3·747
Number of days on which rain fell,	7	11	8
Prevailing winds,	s. 74°26′w·397	n. 70°38′w·236	s. 88°22′w·220

Abstract of Meteorological Observations for August, 1860 *made in Philadelphia, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

1860.	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.									Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.							Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.						
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.
Aug.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc	Inch.	°	°	Inch.	Per ct.	Inch.	Direc	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
○ 1	29·875	·245	74·0	19	7·7	·275	27		N W.	29·312	71·0	4·0	·483	56		(var.)	27·770	61·0	7·0	·000	65		W.
2	29·972	·097	74·2	25	2·8	·419	35		(var.)	29·407	74·7	5·0	·585	55		(var.)	27·812	67·7	6·7	·643	58		WSW
3	29·932	·044	75·3	20½	1·5	·538	46		S E.	29·409	75·7	3·7	·690	70		W.	27·792	72·7	5·7	·737	69		S.
4	29·809	·123	81·0	24½	5·7	·729	55	0·150	S S W.	29·307	82·0	5·7	·752	53		W.	27·737	80·7	7·7	·826	57		(var.)
5	29·811	·050	83·0	17	3·3	·520	36		N W.	29·350	83·3	2·7	·796	56		W.	27·734	76·0	4·3	·813	82	0·489	W.
6	29·884	·074	80·7	21	2·3	·481	35		N E.	29·368	81·3	3·3	·719	58		(var.)	27·762	75·7	5·0	·804	65		S S W.
7	29·802	·083	82·8	23	2·5	·616	40		S S W.	29·255	83·7	2·3	·721	53		W.	27·705	78·0	3·7	·900	59	0·128	S W.
8	29·694	·107	82·2	20	1·3	·792	54	0·007	S W.	29·084	81·0	3·0	·705	55	0·010	W.	27·629	74·7	3·3	·745	64	0·037	W.
☾ 9	29·686	·037	81·8	18	1·0	·567	40		(var.)	29·087	80·7	1·3	·596	48		W.	27·620	75·3	0·7	·683	56		W.
10	29·733	·047	82·7	23	0·8	·703	45		S W.	29·144	80·0	5·3	·651	45	0·785	W.	27·655	72·7	4·0	·822	62	0·665	W.
11	29·804	·071	71·0	13	11·7	·599	78	0·145	N N W.	29·241	74·7	7·3	·577	64	(var.)		27·707	65·3	7·3	·588	74	0·024	W.
12	29·872	·087	74·7	21	4·0	·566	52		N E.	29·261	76·7	3·3	·731	67	2·740	E.	27·717	69·0	5·7	·630	61		(var.)
13	29·711	·161	76·0	18	4·7	·850	77	4·617	(var.)	29·125	69·0	7·7	·586	80		E.	27·632	60·3	9·3	·436	80	0·580	N W.
14	29·845	·134	65·0	8½	11·0	·524	77	2·140	N W.	29·312	67·0	2·7	·469	62		E.	27·771	58·0	5·7	·424	64		N W.
15	29·971	·126	67·0	21	3·3	·367	43		N.	29·422	66·0	0·7	·572	75		E.	27·850	59·7	3·7	·389	50		N N E
● 16	30·013	·042	69·0	23	2·0	·382	41		N E.	29·437	69·0	3·3	·577	64		E.	27·852	62·7	3·0	·456	49		S E.
17	29·941	·072	71·5	24	2·5	·486	46		S W.	29·304	71·0	1·7	·678	73		E.	27·784	69·7	7·0	·655	56		WSW
18	29·762	·179	75·7	24½	4·2	·671	57	0·270	S W.	29·131	75·7	7·0	·746	64	0·125	S E.	27·648	71·7	3·3	·648	54	0·017	W.
19	29·808	·067	78·2	21	2·5	·650	52		(var.)	29·212	76·7	2·3	·762	61		E.	27·667	71·3	3·7	·747	58		W.
20	29·926	·118	78·3	14½	1·8	·750	62		(var.)	29·292	77·7	1·7	·733	61		E.	27·703	72·3	1·7	·804	65		S.
21	29·942	·023	76·3	12	2·0	·790	72	0·812	S E.	29·275	77·7	2·0	·718	64	0·725	W.	27·712	67·7	7·3	·635	90	1·340	W.
22	29·914	·027	76·2	15	1·5	.713	63	0·006	(var.)	29·278	73·3	4·3	·731	82		E.	27·702	69·7	2·7	·627	72	0·047	S E.
☽ 23	29·877	·038	78·5	18	2·3	·728	58	0·149	E.	29·201	75·3	2·0	·758	74	0·310	E.	27·655	72·0	2·3	·619	63	0·017	S S E.
24	29·749	·128	75·7	10½	4·2	·728	73	0·399	E.	29·071	75·3	3·3	·704	73		E.	27·576	71·7	4·3	·689	57	1·045	W.
25	29·656	·093	78·0	15	3·7	·671	54	0·455	W N W	29·082	73·7	2·3	·550	57		(var	27·535	66·0	5·7	·567	67	0·194	W.
26	29·750	·095	72·8	17	5·2	·495	50		W N W	29·175	71·3	2·3	·420	52		(var.)	27·617	61·3	4·7	·510	63		W.
27	29·795	·045	75·3	22	2·8	·500	43	0·015	S W.	29·169	69·3	4·0	·595	76		W.	27·616	63·3	2·0	·513	53		W.
28	29·787	·026	68·8	10	6·8	·458	55	0·095	N.	29·177	62·3	4·0	·510	89	0·170	W.	27·606	57·0	9·0	·498	91	0·379	?
29	29·872	·085	67·3	20	3·8	·363	40		N W.	29·270	64·3	4·3	·398	56		N W.	27·715	54·7	5·7	·393	59		N W.
30	29·895	·072	70·2	24	2·8	·481	47		S W.	29·214	68·3	5·0	·541	68		S E.	27·660	62·7	8·0	·448	52		W S W
○ 31	29·692	·203	75·2	21	5·0	·700	63		S W.	29·037	70·7	5·7	·601	65		W.	27·547	66·0	7·3	·428	51	0·158	W.
Means	29·832	·090	75·4	19	3·8	·584	52	9·260	s81°w	29·270	73·5	3·7	·637	63	4·865	s53°w	27·693	68·0	5·1	·621	63	5·120	s76° w